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FIFTH EDITION

The CARE OF THE CAR

by

ALEXANDER JOHNSTON
EDITOR OF MOTOR

ASSISTED BY
194
MOTORING
EXPERTS

MOTOR

THE NATIONAL MAGAZINE OF MOTORING

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ALEXANDER JOHNSTON

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IN offering the American motoring public this fifth edition of The Care of the Car, MoToR has added to the former volume considerable material to bring the book up to date. A chapter on caring for the electric lighting system and another on power tire pumps were demanded by the developments of the last few years. In certain other departments, the knowledge gained since the first edition went to press has made necessary some revisions of opinion. In the main MoToR can say no more than was said in the foreword to the previous editions.

This volume embodies, not the theories of one man, nor even the experiences of one man, but the combined experience of more than one hundred and ninety-four practical motorists, whose knowledge, gained at first hand, qualifies them to offer helpful advice on the manifold problems that confront the car owner.

The aim in publishing the book is to provide a practical treatise for the practical motorist. "Utility" is the watchword. The subjects selected for discussion relate to the problems that are constantly arising in the average man's motoring. No attempt has been made to deal with engineering questions, which, interesting in themselves, lack the utilitarian character of the homely problems of operation and maintenance, the solution of which contributes so materially to the comfort of the practical motorist.

Those who have assisted in the production of this book are all practical motorists. They speak, therefore, from the vantage point of a wide and varied experience, and this crystallization of a great fund of empirical knowledge cannot but be of the utmost help to other users of the car.

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CHAPTER I

DRIVING AND GENERAL MAINTENANCE

HANDLING THE NEW CAR

WHEN your car has been delivered at your home and placed in the garage, and when you have admired it from all sides and tested it in all sorts of ways, then a careful and common sense inspection and examination and the use of a wrench or two and a little oil and grease may save you many future troubles and also teach you a great deal in regard to the mechanism of said car.

In the first place, every bolt and nut on the car should be gone over with a little gentle pressure to see that they are tight, and this is especially true of manifold and carbureter couplings where the least air leak will make for poor carburetion and misfiring. This tightening of parts should be done every week for the first four.

I have personally noted during this season no fewer than three new cars of first-class makes and in every case the above statement in regard to air leaks was found to be a fact and one that was remedied by a few seconds' work with a wrench.

My second job would be to read the instructions on lubrication given with each car, and after familiarizing myself with the positions of grease cups, oil holes, etc., I would find these important points and know that they contained the proper quantity of oil and grease, as the case might be.

This method not only insures the owner against a scored bearing or a worn part, but also teaches him right at the beginning as to the whereabouts of the various oiling devices and incidentally he is learning by observation as to where and what the internal mechanism of the car looks like.

Now, having reached the point where the car is presumably oiled and tightened, the next step is the proper driving of the same. A new automobile is in precisely the same condition when delivered as a locomotive or other fine piece of machinery; it needs careful limbering up if one is to get the

maximum of efficiency with a minimum of wear. I might add that the locomotive always gets this. It is hauled dead for a while and then gets slow careful driving till bearings are worn in, while the automobile, a much finer piece of machinery, is forced to show its paces at the very outset, with the result, ofttimes, that its efficiency is impaired and curtailed to a greater extent than the owner ever knows. Your new car should be driven during its first thousand miles at a minimum speed, say 15 to 25 miles per hour. If it shows signs of heating it should be given an opportunity to cool before being driven farther.

The oiling of the car should be attended to with more than ordinary care during the early period of its use, grease cups turned down more frequently and a larger amount to cylinders and pistons than will be necessary after the bearings are worn in. The oil in the crankcase should be drained two or three times in the 500 miles and replaced with fresh. You will be surprised at the quantity of grit and dirt that will show in the oil when drained off, which comes from the new bearings and pistons which are throwing off small particles of metal left in the manufacturing of the car.

Lastly, the cleaning of the body of the car should be of the most careful type during its early use.

Washing should be done with a simple flow of water, without spray or force, or finish will be marred, and the longer you can drive it without any cleaning, save dusting, the harder the varnish and finish will become.

J. G. HOFFMAN, Kewanee, Ill.

Importance of the First 1,000 Miles

When a motor car is built the engine is run very little and the parts are fitted exceptionally tight to make them fit snug when the roughness wears off. As a consequence, the car is very stiff, will not show much speed and the motor will not respond readily to the throttle. The car should be run very carefully for the first 1,000 miles at least. The speed should not exceed 30 miles an hour on high, 18 on second and 8 miles per hour on low, under any conditions. By following this limit of speed the various parts of the car have an opportunity to find their seat in relation to the other parts without strain, and then if you are inclined to speed, the car will be fairly free and no harm will result. To force a car for the first 1,000 miles puts an unusual strain on each part, which will result in premature repairs. Don't race the

engine when standing idle, nor trifle with it, nor do stunts with it nor show it off to your friends. Handle the car carefully and always remember you have too much money tied up in the car to risk any harm to it. After the first 1,000 miles drain the oil from the engine in order to remove the minute particles of metal which will accumulate incident to wearing off the rough spots on the pistons, bearings, etc., flush with kerosene or gasoline and put in new oil.

It seems to be the general impression that when a new car arrives the only thing to do is to put in some oil, gasoline and water and start out. Usually everything about a new car is mechanically correct, but it needs careful attention for the first 1,000 miles. Oiling and greasing are perhaps the most important features. The car should be gone over carefully before using it, oil the magneto, fan, generator and starter and other working parts of the motor Carefully look after the grease cups and keep them well filled and turned down. Make it a practice to re-grease everything at least every 150 miles, as this will help to loosen up the car. Adjust the oil level so as to permit more oil to reach the engine for the first 1,000 miles. The careful owner will either go over a new car when he gets it or have a competent mechanic do so to see that the valves, carburetor, make and break mechanism of the magneto, and the electric generator are all properly set and adjusted. This may appear to be unnecessary but in these days of enormous production, inspections at the factory may not be as thorough as they should be.

The bolts and nuts require careful attention after the car has run the first 500 miles. At the end of that time they will be seated properly and rattling will be prevented for a long time if they are carefully tightened. The instruction books supplied with the car should be thoroughly studied and every detail mentioned therein should be attended to. If you are unable to give them attention yourself have your dealer do it.

From time to time squeaks will develop in various parts of the body and running gear, and if the car is greased regularly most of them will disappear.

Some cars will show a tendency to overheat when new. This is caused by friction in wearing off the rough parts of the motor. Give the motor plenty of oil and water and do not force it, and in time this trouble will cease.

N. A. S., Cumberland, Md.

BRAKING WITH THE MOTOR

THERE is a double advantage in using the motor to hold the car back on a long hill, as it not only serves to cool the motor itself, frequently when this is very much needed, but it also saves the brakes, besides a great deal of wear and tear on the driver's nerves.

To use the motor as a brake to the best advantage the gears must be shifted in accordance with the severity of the grade. If nothing out of the ordinary, there is no necessity of changing from the direct drive; if rather bad use second, if very bad use first. Shift on the brow of the hill before the car gathers any momentum and immediately shut off the ignition, taking care in so doing that the switch is not shoved from the magneto clear over to the battery. Where the car is not equipped with a good kick switch, with plenty of space between the points, test his by pressing the accelerator gingerly. If there is no response the car is then running the motor and the latter is acting as an air compressor. The lower the gear, occasioned by dropping into second or first, the faster the motor must run for each revolution of the rear wheels and the greater its retarding power. Supplement this by using the pedal brake from time to time. If much recourse to the latter be necessary a lower gear should have been engaged at the top of the hill, and the driver will soon learn to gauge this from experience. Most cars have the emergency and clutch interconnected so this brake must not be touched, but it is never necessary. No harm whatever can result to the motor, as even when descending a steep grade with low engaged, it is not working anything like as hard as it would have to in climbing the same hill. Moreover, it is working on cool air and the brief respite puts it in better condition to climb the next hill, for there's always a next. When the novice has mastered the use of the motor as a brake he has nothing to fear on the worst hills.

RICHARD WRIGHT, New York.

Considerations Pro and Con

To summarize the points in favor of this practice: (a) it relieves the brakes of wear and strain; (b) it scavenges and cools the engine; (c) it allows the operator a rest from the labor of working the service brake, which in case this brake has a very stiff spring, is a point worth while; (d) it keeps the car under perfect control.

The points against, may be stated as follows: (a) A certain amount of oil is forced into the cylinders which is not burned

as the charge of gas injected is not exploded; (b) it imposes a certain amount of strain on the rear axle, transmission clutch and engine.

In considering the relative weight of these points it will appear that the arguments against braking with the engine are decidedly weaker than the advantages to be gained from it. The amount of oil injected is not sufficient to prevent regular firing when the engine is again called upon to do its work. The combined cost of the "wasted" gasoline and oil, and the wear on engine, transmission, etc., is probably less than the wear on the brake mechanism which is thus avoided. The benefit of giving the engine a bath of cool gasoline vapor and an airing are considerable, especially if the trip is a long one and there are ascents necessitating much work in the gears alternating with the steep descents. A driver who is inclined to conserve his energy will not fail to appreciate the saving to his legs, as well as to his brakes, to be had by braking with the engine. Should it be necessary to bring the car to a full stop the clutch is disengaged and the brakes applied just as in driving on level roads. On the other hand, should there be a need for power, the switch is turned on and the engine is at work and in gear.

All this presupposes a certain manner of using the engine. On reaching the top of the hill to be descended the gears are set in intermediate or in low speed, according to whether the descent is moderately or very steep. The ignition switch is set in the "off" position, the clutch left engaged and both brakes are left off. Should the braking effect thus obtained be not sufficient either brake may be applied, leaving the clutch still in engagement. It goes without saying that the throttle should be closed when the ignition is cut off. When the declivity is an easy one with an abrupt drop at some point, the gears may be set in low and the foot brake used with the clutch out in the easy part of the descent, the clutch being let in only as the steep part of the grade is reached. In fact, there are several minor variations to the manner in which engine braking may be done, the essentials being that the transmission should be in one of the lower gears, and the ignition cut off.

DR. C. D. ENFIELD, Jefferson, Iowa.

SLIPPING THE CLUTCH

WHETHER or not occasional slipping of the clutch is permissible depends to a certain extent upon the type of clutch with which the car is equipped. As far as the motor is concerned

there is no doubt that this practice is less harmful than laboring up the last few feet of a hill in high gear and with full throttle opening. But by far the better method is that of shifting to second, or even if necessary the low speed, until the car has passed the critical point. Many drivers are apparently unaware of the fact that although the power of a motor for any given throttle opening varies with the speed at which it is running, yet the torque or turning moment remains very nearly constant. Thus, though an engine which is turning over slowly on full throttle, develops comparatively little power, there are, nevertheless, enormous strains brought to bear on all parts of the engine and transmission line, which are obviously most injurious to them. Now, if under such conditions, the second or first gear is engaged, the motor will develop more power with less throttle, and consequently with less torsional stress, simply because it is running at greater speed. Slipping the clutch produces an almost identical effect. Namely, it allows the motor to pick up speed and power. But, since no gear reduction has been effected, the moment the clutch takes the load again the former conditions are restored, and more slipping is necessary. Hence, though this relieves the engine of considerable harmful strain, it is not nearly so effective as a change of gear would be, though in conjunction with the latter it will often render material assistance in working the car through a heavy piece of road, when the motor might otherwise be stalled.

Now, let us consider the effect of slippping on the clutch itself. Clutches of the disc or plate type may, if they are in good condition, be slipped without injury, especially if they revolve in a bath of oil. This is not the case, however, with the cone or the majority of disc clutches, particularly if they are faced with leather or some other substance which will char under excessive friction. The facing of such a member may be utterly ruined if slipping is frequently resorted to. At first its surface will become smooth and glassy, and will not always hold the load properly. This will produce more friction and finally the facing will burn and crumble away. Facings of asbestos fabric, though they will not scorch, are yet liable to assume this same glassy surface, under extreme conditions, thereby causing the clutch to become unreliable. To sum up the above facts, it may be said that where a change of gear will produce the desired results it is better not to slip the clutch at all, but in a case where the car has become stuck, or nearly so, in spite of gear shifting, a little judicious pressure of the pedal may, if necessary, be tried.

Roy Wood, Vancouver, B. C.

Disadvantages Outnumber the Benefits

Speaking generally the clutch is not designed for the purpose of assisting the high gear, or any gear, on the crest of a hill. It is constructed to "slip" that it may engage gradually, and so avoid what would otherwise be instant application of the full power between the motor and driving shaft, with consequent shock to the crank shaft, gears differential, rear axle, etc.

The "practice of slipping the clutch to assist the high gear" was probably born of a desire on the part of the operator to "make the hill on high gear."

In answering the question literally the reasons "for" are, after all, only apparent. They are:

1. Shock eliminated in transmission by reason of not changing gears.
2. Elimination of jerk and shock in rear system, accompanying "picking up" from a practical standstill.
3. Saving of friction in rear tires, which would accompany the get-away on a lower gear.

The reasons "against" are many and most important.

1. The necessity for assisting the high gear on a grade does not present itself until the motor begins to labor. It will be universally conceded that no motor should be allowed to labor. Hence it is obvious that reason for slipping the clutch should not arise.
2. Constant slipping of the clutch means a worn and consequently inefficient clutch, especially in the case of the leather-faced type.
3. It is bound to result at times in racing the motor with consequent heating.
4. Half the time the operator will have to change gears after all, and the momentum of the car will have become so slight that a labored pick up is the result.
5. Anything saved on the tires is offset by the practice in general being injurious.
6. In short, a motor car is provided with change speed gears, whose functions should be exercised before the necessity for clutch slipping arises. F. N. C., Summit, N. J.

IDEAS FOR BETTERING CAR PERFORMANCE

IN August, 1914, I purchased a 1915 four-cylinder car of a well known make which was not all that I desired in comfort and accessibility.

Being short and stout I had trouble in reaching gear

lever. To overcome this I made a 3½ inch offset extension of 4 inch which I attached to gear lever, and can now reach and change gears with ease.

I next placed on the forward doors 8 inch x 2 inch pads to correspond with upholstery which gave me a place to rest elbow and improved looks of car.

On the floor board where my left foot would naturally rest I placed a block of wood 1½ inches wide, 5 inches long and ¾ inch thick. At the right end of block on floor I placed a large horn button ⅞ inch from floor and ⅛ inch above block. This I connected to the same circuit that the hand electric button was on which was in a box on side of steering post. To blow horn with foot all that was necessary was to slide foot to right until it hit the button. By the use of this foot button I can keep both hands on the steering wheel or should I desire to use both feet on pedals and blow horn at same time can use hand button.

To have the tools handy that are used mostly I made a tray of mahogany that is 1 inch deep, 9 inches wide and 15 inches long. I cut recesses in this that fitted three sizes of S wrenches, one screwdriver, one adjustable small wrench, one combination pliers, one tire gauge and one tire valve tool. To eliminate noise I fastened a piece of leather the size of tray on one side. The tray is kept on top of other tools in tool box on running board.

This model car had a drip pan that ran from front of car to rear of flywheel about 2 inches below base of engine. When I wished to remove carburetor or change oil it was necessary to remove drip pan which was a hard and dirty job. To overcome this I cut 9-inch holes in pan directly under carbureter and oil outlet and fastened over each hole a sliding cover. Now when I wish to remove oil or carbureter I lay under car and open the slide to the part I wish to get at and can do work with very lttle effort.

The oiling system of this car is a combination pump and splash which sent oil through an oil lead to a dial on dash and back to crankcase. At the pump outlet dirt would settle and oil would not rise. At this outlet I placed a brass T and on other end of T a petcock. The oil lead was fastened on top of T and then back to dash. When dial did not register I would open petcock which engine was running and pump out dirt.

To prevent car from being stolen I cut off starter pedal flush with floor board and on the part I removed, a piece

of brass pipe was fitted that was 2 inches longer and placed it over the lower section which was in the hole in floor board. When leaving car unattended I remove starter button and place it in my pocket. By so doing there is nothing above floor for would-be thief to start engine with.

Having trouble with the front valve springs getting dirty I placed on left front side of timing gear case a piece of zinc 12 inches square which keeps dirt from valve springs and carbureter.

While I have made a great many more improvements I think that the ones described are the most important.

C. A. Du Bois, Waltham, Mass.

Replacing Steering Knuckle Bushings

To simplify the work of oiling the spring leaves I have used a method which provides a constant oil supply with the minimum of attention.

Small oil soaked sponges were placed in the pockets where the springs were attached to the frame members. An occasional replenishment of the oil on the sponges was all the attention needed.

All cars are not so provided with convenient pockets for this method, and a procedure which I have found especially quick and resultful is by mixing light cylinder oil with an equal part of kerosene and adding small quantities of powdered graphite; this is then applied to the edges of the springs with a brush.

The fluidity of this liquid causes it to penetrate between the spring leaves, carrying the graphite particles with it.

I use a squirt can as a container for this lubricant and into the spout I forced the wooden end of a small brush. This is convenient as the can may be shaken to mix up the ingredients without spilling of the contents and the brush is not mislaid.

Among the details of the running gear that result with vibration and rattle due to wear are the bushings in the steering connections, spring shackles and front wheel spindles.

The noise and lost motion is not overcome by tightening the bolts, what is needed is the renewal of the bushings. Rather than lay the car up in a repair shop for this work, it is usually neglected and the car runs noisily on.

Without expenditure for special tools to accomplish the work I have found several simple expedients helpful in renewing the worn bushings.

With a hacksaw, the bushing shell may be cut across which cut relieves the external pressure and the bushing slips out easily. The forcing of the new bushing into place may be accomplished by a threaded bolt and nut. The bushing when eased off at one end with a file to start it into the hole can then be pressed into place by means of the bolt and two wrenches. Use a suitable washer under the face of the nut to have it turn easily.

On some wheel spindles, bushings with thrust ends are inserted at either side. To remove these I have found that a steel rod split with a saw for several inches and sprung apart at the ends will, with the aid of a hammer, quickly displace these worn members for their replacement with new ones.

After the bushing is pressed into place you will probably find that it will need reaming out before the bolt will pass through. A flat file ground to a cutting edge and made as wide as the retaining bolt in diameter, makes an excellent reaming tool if centered by two semi-circular pieces of wood at the sides. A slight taper on the reamer cutting edges permits of finishing the inside of the bushing until a snug fit for the bolt is obtained.

I have on occasions used sawed out bushings over again, by fitting a thin tin sleeve or liner around the outer circumference and forcing them back into place. This liner closes the bushing making the inside diameter smaller.

A difficulty oftentimes is experienced in keeping the cap on ball and socket connections in the steering gear and radius rods snug. It will be found if split lock washers are placed under the bolt heads that hold the removable cap and the faces of the sockets are filed off for clearance that the connections will remain tight and snug fitting with the least attention.

G. A. Luers, Washington, D. C.

Petcock On Manifold for Feeding Air

There was one device I placed on my motor that served several purposes, but was extremely simple. It was a regular one-quarter inch drip cock, screwed into the intake manifold just where it branched to go to the different cylinders. To the handle of the drip cock was riveted

an iron rod that came through the dash and terminated in a handle. A simple yet effective arrangement. Then when the motor was warmed up and had a nice run ahead, I could from my seat open the cock in the manifold and admit excess air above the carbureter, giving me an average of ten to fifteen per cent less gas consumption, besides reducing carbon formation.

Once in a while I fed water or kerosene into the cylinders by means of this device, and found it useful in keeping down carbon in this way as well. When cold weather came I found I didn't need excess air and did need a primer, so I retained the device with the modification that I soldered into the air opening a small brass tube that dipped into the float chamber of the carbureter. Of course I was careful to see that it did not interfere with the float action. Then by keeping the throttle closed, opening the petcock and turning over the motor, the suction in the manifold drew gasoline directly from the float chamber and sprayed it directly into the manifold near the cylinders, constituting a very effective priming device.

W. Penn Lukens, Woodlyn, Pa.

Repairing Damaged Insulation

The old question of getting home if a tire blows out and you have no spare has been given any number of solutions. If the hole is not too large blowout patches can be used but the repair I had to make was of such nature that neither inner nor outer blowout patches could be made to hold. Therefore, I secured a piece of heavy close-woven cloth, such as a towel or a piece of canvas. The cloth was wrapped around the tube at the point that when the tube was inserted it will come directly over the hole in the casing. The tire is then replaced and blown up sufficiently that the tube presses against the tire, after which the damaged section of the tire is wrapped tightly with wire or rope. Thus, the cloth makes a new fabric lining and the rope keeps the tube from pushing through the tire. A repair of this nature is usually good for many miles and has the advantage that a full pressure of air can be maintained.

When the insulation of wiring becomes damaged it is usually necessary to discard it and replace with new wire. Instead of replacing the wiring I make use of the pitch taken from dry batteries in repairing the insulation. A quantity of the pitch is melted, and after the damaged in-

sulation is cut away alternate layers of pitch and tape are laid on. The pitch will adhere perfectly to the other insulation and the wiring is then as good as new. This pitch can also be used in repairing many other short-circuits in the coils, magneto, etc.

On one occasion I skidded into a ditch which bent the steering arm and threw a front wheel out of alignment. Adjustment for this was provided, but could not be used in this case as the wheel was too badly out of alignment. The leverage of a jack was used to make the repair. I blocked the front wheel from the center of the rim to the car frame. The jack was then placed between the spring and steering arm, leverage applied, which forced the arm back sufficient to provide the proper alignment. This is but one of the many uses to which a jack can be put.

The color of the exhaust flame is the best indicator to determine the correct carbureter adjustment and the exact working condition of each cylinder. The engine on my car has holes drilled in the exhaust near each cylinder, fitted with plugs, which makes it quite easy to examine each cylinder individually. In the absence of these plugs, and if the muffler cut-out in near enough to the engine to throw out a flame, the operating condition of the engine as a whole can be determined. Thus, the yellow flame indicates an over-rich mixture; a pale blue flame, a lean mixture and a deep blue flame, a powerful and normal mixture. The test should be made with a retarded spark and open throttle. Should the exhaust be blue with yellow streaks, it indicates incomplete combustion. Therefore, it is quite easy to determine the operating condition of the engine and apply any necessary remedies.

To satisfactorily repair fenders or bodies is quite often a problem. The method I make use of consists of shaping a block of wood to conform to the curve of the body at the damaged point. By the use of a hammer and the block of wood the body can be ironed out without scarcely leaving a trace of the damage. Fenders can be repaired equally as well if the bends are not so sharp that reshaping will crack the metal. The fenders should be removed and laid on a solid surface and repaired by the method suggested above. If a little care and patience are used the results will be found satisfactory. The use of this method eliminates the many small dents caused by using the hammer alone.

N. A. S., Cumberland, Md.

CLEANING THE WINDSHIELD

RUB a half and half mixture of kerosene and glycerine on the clouded surface of the glass. A small bottle of this mixture, tightly corked, may be wrapped in a little waste put in a half pound baking powder can and stored away in the tool box or some other convenient place about the car. When it begins to rain pour a small portion of the mixture on the waste, rub over the damp surface of glass, and all water will spread out in a thin sheet, wherever it comes in contact with the glycerine, instead of forming in little globules, which are so detrimental to the vision.

CARL L. JEFFRIES, Columbus, Ohio.

Paraffine in Gasoline Solution

Take about half a pint of gasoline and dissolve in it all the paraffine which it will take up; i. e., make a saturated solution of paraffine in gasoline. The paraffine is not very soluble and but little need be used. Cut it into very fine shavings with a knife and let it stand in the gasoline for several hours, stirring occasionally to facilitate solution. After the solution is made it may be bottled and rubbed lightly upon the glass as often as is found necessary. A shield covered with this solution will on the evaporation of the gasoline, be coated with a very thin layer of paraffine which will in no way interfere with its transparency, but will keep from clouding in either damp or cold weather.

JOHN W. TOWNSEND, Lockport, N. Y.

A Glycerine-Alcohol Mixture

Mix together equal parts of ordinary glycerine and alcohol and apply with a wide camel's hair brush, painting it smoothly on the glass. The alcohol will soon evaporate but the glycerine will remain, making the glass bright and clear in any kind of weather. This method is excellent in a snowstorm as the flakes of snow on striking the glass will not stick to it but will slide right down. This mixture will remain on the glass for several days before it has to be renewed. When applying it care must be taken not to let the alcohol from the brush drip down to the dashboard as it will leave streaks in the varnish. A piece of waste dipped in gasoline will easily remove the glycerine and clean the glass, but care must be taken not to get the gasoline on any part of the car as it will leave spots.

WM. COHN, New York City.

Plain Kerosene

A small clean piece of waste or cloth is moistened in coal oil or kerosene. An occasional wipe of the glass with this cloth will serve the purpose of keeping the wind shield quite clear and transparent. Another advantage of this treatment is that kerosene possesses a remarkable glass cleaning power, so that when the shield is wiped dry with a cloth or piece of waste it remains very clear and absolutely devoid of streaks.

RUDOLPH KYSELA, Denver, Colo.

Straight Glycerine

Carry a piece of cloth soaked with glycerine in a closed tin can or some other receptacle. To apply, first wipe off the moisture and then give the glass a thin, even coating. The glass will appear rather dull at first but not necessarily opaque. As soon as it has been rained upon it will become clear again. As to cold weather, it need only be pointed out that since glycerine freezes at a very low temperature, a thin coating of it will serve to keep frost off the glass. This will not need to be renewed often and a little can be made to go a long way. J. T. L., Boonton, N. J.

INSURANCE PROBLEMS AND SOLUTIONS

AUTOMOBILE insurance is obtainable in many forms, and it is now possible to be protected against all the hazards incident to the ownership or operation of a car, with policy combination so varied as to suit the requirements of almost all. Thus, there is a fire and transportation policy, to which can be added by rider, protection against collision, theft and damage to property of others. Or the personal liability policy only may be taken, which also permits of coverage against damage to property of others and collision. However, either fire or liability insurance must be carried as a basis of securing the other protection.

Motor car owners generally seem to hold to the opinion that the apparent hazard should be the basis for judging the necessity of the various forms of insurance. For this reason, the fire, transportation and collision coverage is not desired by many, as these are hazards the prudent owner can greatly diminish. Although the theft hazard is great, unfortunately the insurance is obtainable only in combination with the fire and transportation policy. However, many owners take the less desirable forms in order to secure the theft protection.

But a much different view is taken in regard to the liability and property damage forms. The average motorist realizes that even though he is a careful driver he cannot control the actions of pedestrians and vehicles. Then, too, he knows that personal injuries are often serious and the consequent damage suit is expensive even though the verdict were in his favor. For these reasons the money is considered well spent, even for the satisfaction and assurance of having the protection. The protection afforded by the policy is very comprehensive, insurance being usually secured for $5,000 for injury to one person and $10,000 for injury to more than one person, and property damage for $1,000. These are known as the standard amounts, but they can be increased by the payment of a proportionate additional premium.

When all things are considered, and in view of the admittedly growing hazard, the cost of insurance for the average car will be found to be quite reasonable. Take as an illustration a 1917 model car listed at $1,250. The fire insurance rate on this car is $1 per $100, while that of theft is $1.50, or a premium of $25 for $1,000 insurance. The liability and property damage rates are based on the S. A. E. horse-power of the car. Thus, for a car having a horse-power of twenty-five, the liability insurance costs $29.75 and the property damage $7.45. For reasonably complete protection, therefore, the insurance cost is only $62.20, and if the fire and theft is dispensed with the cost is reduced to $37.20.

The rates on the classes of insurance just mentioned vary with the territory. The fire and theft rate applies to the entire State of Maryland, while the liability and property damage rates apply to the territory outside of Baltimore city, where they are $31.50 and $10.15, respectively. This rate discrimination is puzzling to many; the principal reasons for it being traffic conditions and regulation, the theft experience and the general experience as to losses classed by territories. While the rate distinction is made as between territories, the owner taking out insurance in the lower rates territories is fully covered while touring in the higher rates district.

From my own experience and observation I find that, if the loss is one covered by the policy and if all its conditions are complied with, adjustments are usually most liberal and prompt. I have never heard of payment being refused on small technicalities, and in fact the insurance companies usually pay more than the actual loss rather than make a few dollars a basis of contention and dissatisfaction. An ap-

parently unsatisfactory adjustment is usually traceable to one or more of the following causes: First, ignorance as to what is covered by the policy; second, placing a value on the car far out of proportion to its real worth; third, that some condition of the policy had been violated; fourth, the insurance was carried in a company financially unsound.

However, in the aggregate it would seem automobile insurance has been placed on a very satisfactory basis. But much criticism is expressed against the amount of insurance granted and the rates charged as the car grows older. This criticism seems to be well founded, as can be readily seen by again considering the car referred to above. After this car has become six months old, the fire and theft rates are advanced 50 cents, or to $3 per $100, while the insurance value of the car is depreciated 40 per cent. As a matter of fact, the composition of this rate shows that $1.75 of it is for the fire hazard and $1.25 for the theft feature, really an advance of 75 cents for the fire insurance and a reduction of 25 cents for the theft. An adjustment of rates would seem to be equitable and the rate could reasonably be allowed to remain the same, the theft reduction compensating for the admittedly increased fire hazard. While a 20 per cent depreciation charge would be reasonable in view of the high quality of present-day automobiles.

However, when all things are considered, insurance and insurance companies seem to operate on the basis of fair treatment to all, and it may safely be said that any expenditure for insurance can be looked upon as an investment in security against loss and freedom from anxiety.

N. A. S., Cumberland, Md.

Insurance of Course, But How Much?

To insure or not to insure is not the question, but to what extent shall we insure is debatable. Shall it be for fire and theft, liability for personal and property damage, or for collision?

The majority of motorists probably give first consideration to fire insurance. Usually one policy, at a small additional cost, covers both fire and theft. The so-called "floater policy" covering car against loss by fire or theft, whether at home or away is the most satisfactory.

Liability insurance is a new term to many and most beginners until they have had an accident have the idea that it will be unnecessary to insure against loss due to accidents.

Every motor car owner undoubtedly should carry some insurance. The amount and kind will depend largely upon

Locality;

Whether the owner drives or hires a driver;

The experience of the driver, etc.

Practically every large corporation, operating motor vehicles, carries insurance for fire and theft; also for liability for personal and property damage. Our laws are very strict and the courts most efficient with regard to accidents in which motor cars have a part. It is a rare thing to hear of an accident in which a motor car figures and not to find the motorist blamed because of alleged reckless or fast driving. The owner of a motor car is looked upon as one able to pay for any damage done and also as one guilty until proven innocent. However, we are gradually getting away from this condition due to the fact that the number of persons operating cars is rapidly increasing and also due to the fact that great numbers of people in moderate circumstances now own cars.

Insurance against fire and theft is a positive kind of insurance. For example: I may buy a new car for $1,000 and secure a policy for $800, and if the car is destroyed by fire or stolen I will receive $800. On the other hand, if I carry liability insurance and in driving along the street strike another vehicle, causing personal damage or property damage, I will be protected in the courts against loss up to a fixed amount. In some policies the limit is $1,000; in others $5,000 or $10,000. If I carry no insurance against fire or theft I can only lose the value of the car, while if I carry no liability insurance I may stand a loss of thousands of dollars, although my car may be of small value. Therefore, I would say that the owner of limited means driving a car in a city where traffic is heavy should at least carry liability insurance against personal and property damage.

The first year I owned a car I carried no insurance whatever, after that I carried fire and theft and lately have added liability. I have had only one loss, that being a spare tire, value $30, and adjustment was promptly made for the entire amount. Some policies would have only given the loss in excess of $25. Such a policy is unsatisfactory and should not be taken out. I have never had a case where liability was even probable, but I have had some narrow escapes. You may pride yourself upon your skillful and careful driving, but if a horse becomes frightened, causing damage, you may

soon thereafter find your way to court. You can take positive precaution against fire and theft, but you have no way to avoid the possibility of liability loss unless you leave your car at home.

I believe motor car insurance, as a whole, is well worked out. The rates seem rather high, but losses are extremely uncertain and the insurance companies can only make the rates high and lower them as conditions improve. The losses from fire, due to explosion, are now quite rare. Losses due to theft are increasing if anything, but strict laws making stealing a felony are now going into effect in many states and will help in this quarter. Automobile clubs have also been of great assistance along this line. Vigorous defense of motorists against unreasonable damage cases will lower liability insurance rates. Liability rates will also decrease when the majority of owners carry such insurance, thus decreasing the percentage of losses and also compelling the plaintiff in damage cases to meet competent legal defense.

Collision insurance rates are very high, and such insurance can be neglected better than any of the other kinds.

I believe there is a chance for improvement in the method of determining liability rates. At present the rate is determined by an arbitrary horse-power rating of the motor. Consideration should be given to the experience and character of the driver. A man who has driven a car for ten years without an accident, surely should not be classed with the beginner. Also, an old noisy car, apt to fall to pieces at any time, is a greater menace than a new or well repaired car.

Louis R. Lee, Columbus, O.

AS WE CLEAN THE CAR NOWADAYS

IT may surprise many owners who have not used these preparations to learn that by the use of them a dusty, spotted body may, in about thirty minutes, be made to look as if it had just come from the paint shop. For a few cents the whole body may be given a high polish, which not only adds to the appearance of the car, but protects it from the action of mud and water and injurious agents. Many owners seem to assume that the motor car body will retain its luster indefinitely with nothing more than an occasional dusting. This of course is ridiculous, and to achieve permanent beauty of finish the owner must make up his mind to a regular and systematic cleansing and polishing of the vehicle. If this is done once a week the results will be all that could be hoped for, in spite of the fact that the motor car

travels over muddy roads through rain and snow and sleet and stands in a closed garage where injurious gases from the exhaust have ample opportunity to do their wicked worst on the delicate surfaces of lustrous varnish and enamel.

Right here we will note the fact that the finish of the average new car is abominably neglected and abused by the ordinary owner during the period of early ownership. It takes a month or even two for the highly polished finish of the modern car thoroughly to set and season. During this period the owner of a new car should be very careful of it and give it the most scrupulous care and attention. If mud gets a chance to become thoroughly set during this period, the results will be disastrous.

The market now affords a number of liquid polishes, which will give excellent results in nearly all instances if they are used as directed by the manufacturers. There really are two varieties of liquid polishes, those which are sprayed on to the body surfaces and those which are rubbed on with a piece of cloth. The results are about the same in either case. The time for using the sprayed polish is less than for the other types. However, there are certain advantages in the use of wax polishes, which make the need for application less frequent, so that the total time consumed in grooming the car will be about the same for liquids and wax polishes.

Wax polishes have been on the market for a number of years and their application is a simple matter. A piece of clean cheesecloth is used for applying the wax to the surface and another cloth is utilized for distributing the wax evenly so that the result will be a thin film all over the finish. It is recommended that the wax be put inside two or three thicknesses of cheesecloth so the substance will work through and deposit evenly over the surface. Some motorists make the mistake of using too much of the wax, believing that the more used the better. This is not so and it is surprising how little of the wax is needed to obtain the desired results. The housewife usually knows about wax polishes, having used or seen them used in polishing furniture, and a word from her may save time and energy. Before applying the wax the body should be well cleaned, because if there are surface spots, they are likely to show through. It is not necessary to use the wax every day, and it will be found that a thorough job will last from four days to a week, depending upon the weather conditions in the meantime.

After a good polishing has been given the car in the early part of the week, a little rubbing with a clean cloth will bring back the luster without further application of wax. However, do not attempt to repolish if there is mud on the body, because this will almost certainly scratch the varnish.

Wax can be used for the body, fenders, hood and other

bright parts, and a new use for it has been found. If the underside of the fenders are once thoroughly cleaned and covered with a fairly good coating of wax, it will be found there will be less of a mud deposit when the car comes in off the road, and that which is deposited can be removed more easily.

Most wax polishers use carnauba as a base. Carnauba wax is exuded by the leaves of Corypha cerifera, a palm indigenous to tropical South America. This palm is found in the states of Bahia, Pernambuco, Rio Grande do Norte, Piauhy, Ceara, Maranhao and Matto Grosso, Brazil. It is especially plentiful in the province of Ceara. The wax is gathered during the months from September to March by pulling off the leaves before they have fully opened and drying them for two or three days in the sun. During these six months the leaves can be cut twice a month, a good worker cutting about 1,500 leaves per day. About 2,000 to 4,000 leaves are required to produce thirty-five pounds of wax. The white powdery mass covering the surface of the leaves is first brushed off, then scraped off and thrown into boiling water. After fifteen to twenty minutes the wax collects on the top as a dough-like mass and is taken off after cooling. The crude wax, as obtained from the plant, is dirty greenish or yellowish; it is very hard and so brittle that it can readily be powdered.

Recently there have come on the market a great number of polishes which are designed to be spread on to the surface. Many of these polishes have a lemon-oil base which is mixed with some substance which will fill in the small surface holes and scratches.

The outfits usually sell for $1.25 and the liquid is applied with a sprayer much the same as an ordinary plant sprayer. In using these polishes the same rules apply as for the waxes. The body must be cleaned first to remove mud spots. While some makers claim that the polish will remove mud, it will be safer first to remove the mud with water, so that there will be less chance for scratching. The mud should not be rubbed off, but should be loosened and floated off with water. The polish may be sprayed over a dusty surface and then wiped off with a piece of cheesecloth.

After spraying the polish over the surface, a piece of clean cheesecloth should be used to wipe off the excess. There is no need for rubbing vigorously. A few straight line strokes with the cloth over the sprayed surface will be found sufficient to give a high luster. It is best to spray the whole body before starting to wipe off the excess. It will be found that only about ten to fifteen minutes is required to do the actual spraying, although about thirty minutes may be needed to complete the entire work of polishing. Do the work indoors.

A weekly brushing of the top both inside and outside will add materially to its life. Fabric tops never should be cleaned with gasoline, kerosene or similar oil, because these attack the rubber in the top and cause the layers to separate. Good castile soap and water should be the cleaning medium and a stiff brush used to rub it in. After using soap in this way the spot should be washed with clear water and rubbed dry with a piece of chamois. If impure soap is used, it may result in a portion of the top becoming spotted.

Upholstery certainly looks better when it is clean, and its wearing qualities will not be affected by such procedure. As a matter of fact the upholstery should be cleaned once a week. This does not mean merely wiping the surface of the seat cushions, but includes wiping under the piping and in the corners where dirt inevitably accumulates. After the dust has been removed, leather upholstery may be cleaned by wiping it with a clean cloth saturated with a weak ammonia solution. Castile soap and water also is effective in cleaning leather but gasoline and similar liquids should not be used for the reason that they cause cracking. It is recommended that the leather be treated occasionally by applying a light coat of linseed oil thinned with vinegar. This solution should be applied with a cloth and allowed to remain for a few hours, after which the upholstery may be wiped. Where imitation leather is used, soap and water is recommended for removing spots and linseed oil or sweet oil in small quantities for brightening up the finish.

When detachable upholstery covers become greatly soiled, they can be removed and sent to a cleaning establishment. Small spots can be removed with gasoline or with soap and water.

It may appear to many car owners that the washing of an automobile is a simple matter requiring little skill and less knowledge about body finish. As a matter of fact there are many things to be remembered in this connection, neglect of which may result in the finish of the car being permanently injured. A dirty car should not be allowed to remain so for more than a day, especially if the mud deposit on the body and running gear is at all heavy. The longer the body remains spotted, the more difficult it will be to remove the spots and restore its pristine luster. It is even recommended that dust which has accumulated be washed off rather than dusted off.

In washing a car body only clear water should be used, and this should be neither too cold nor too warm. Water at about 50° F. is best. A large sponge, a clean pail and running water from a hose or sprinkling can will do the work in a short time. Soak the sponge in the clear water and allow the water to run down the sides of the panels. Do not use high water pressure if the body is new and there are heavy mud spots, because the

water may cause some of the small sand particles to become imbedded in the finish. A good plan is to hold the sponge at the top of a panel and squeeze it at intervals so the water will run down over the finish. The hose will keep the sponge saturated so there will be no interruption in the work. If small, hard mud deposits are present do not attempt to scrape them off, but rather allow the water to wash them away. This will avoid scratching the finish. Often the mud on the panels, if allowed to soak for a few minutes, will fall off as soon as a stream of water flows over it. Never use soap on a body, except perhaps for removing small grease or oil spots. Use a small piece of cloth well covered with castile soap suds for removing grease on the panels and use water freely afterwards. Some motorists saturate the cloth with gasoline for removing grease.

If the hood should be hot do not wash it, as it is likely that discoloration will result. In washing the hood use only the soaked sponge and do the work carefully so that as little water as possible will work through into the motor compartment. In cleaning the radiator direct the stream of water from the rear instead of the front, for in this way no water will make its way into the mechanism.

Use a clean chamois skin for drying and rub the chamois in straight lines. It is not necessary to completely dry the body by rubbing with chamois; in fact, it is best to allow a little moisture to remain to be evaporated. Road oil should be removed from the body as soon as possible. If it is found difficult to remove the spots by the ordinary methods, salt butter may be used. Spread a little butter over each spot and allow it to remain for about fifteen minutes and then rub the oil off. Kerosene is effective in removing the oil if the work is done within five hours. Saturate a piece of cloth with the kerosene and apply locally.

The cleaning of the running gear is by no means a pleasant job, especially if the under parts of the car are muddy. At best it is a job which the car owner is not very willing to undertake since it takes considerable time. If it is desired to clean the running gear, soap and water should be used. Make a soap solution by dissolving two pounds of good soft soap in one gallon of warm water. After as much mud as possible has been removed by the use of clear water, use the soap suds. The sponge for spreading this solution should not be the same as that used for the body, and it is even advisable to use a different pail. The longer that mud is allowed to accumulate on the chassis, the more difficult it will be to remove, and the owner will see the advisability of giving it his attention as early as possible after the car has returned from a run. Mud under the fenders can be removed more quickly if a small wooden stick is

used for scraping, but this need not be done unless the deposit is rather heavy. It is worth while removing caky deposits from the underneath parts such as the torque tube, universal housings, rear axle, brake drums, etc., for the mud has a destructive effect in time.

In flushing around these moving parts care should be taken so that no water gets to bearing surfaces. This has special reference to such places as the braking mechanism, the steering connections, etc.

Before using any sponge on the car it should be given a good cleaning in hot water. Many sponges when sold contain gritty substances which if rubbed over the body may scratch it. Sponge dealers often use "filler" in their sponges, the filler being usually in the form of some soluble substance of high specific gravity to increase the weight of the sponge. The "filler" in most cases will scratch the finish and cause permanent injury. Aside from filler the sponge may contain sand. Soak the sponge in hot water, in which some soap has been dissolved and squeeze it in the soap water a few times. After the sponge has been in use the hot water cleaning will help materially.

CHAPTER II

THE IGNITION SYSTEM

REMEDIES FOR ELECTRICAL TROUBLES

THE most interesting repair I have ever made was not unusual in any way except in its difficulty of analysis and the simplicity of the remedy. It was made upon the Atwater Kent distributer head on a Saxon four-cylinder car.

All morning the car was misbehaving—was hard to start, ran on two or three cylinders, and sometimes fired in the muffler. But about noon it gave a couple of tremendous muffler explosions and quit; just lay down in disgust and refused to do a thing. Earlier in the day I had traced the trouble to the distributer head, so now I began an exhaustive search for the trouble. When cleaning and resetting the contact points produced no results. I tried cleaning up the whole head, examining the automatic advance, checking up the firing points, etc., but found nothing apparently wrong, yet got no results when I tried to crank the car. Then I noticed that by priming the motor and turning it over very slowly I got an explosion or two, while spinning the motor produced no results. But it was an hour and a half, after I had carefully dissected the whole head, that I found the trouble in a worn latch that operated the contact points. This latch is of glass hard steel, is about 1 inch x ⅛ inch x ⅛ inch and is pulled forward and released by notches on the timer shaft. The latch is held against the shaft by a very light spring.

In this case the spring had tended to hold the latch at an angle with the shaft, so that one corner only engaged the shaft notches, and the double duty on that corner had worn it down so that sometimes it caught (especially at slow speed) and most of the time it slipped off too soon. Probably I was already tired and exasperated by my search for the trouble, for it was half an hour more after trying various expedients, before the very obvious remedy occurred to me of twisting the holding spring so that it had a pronounced tendency to hold the good corner of the latch against the shaft notches.

With this change everything seemed to work O. K., and with the spark plug lying on the cylinders I checked up timing, etc. But when the plugs were replaced in the cylinders the motor wouldn't give a single explosion. It was possibly fifteen minutes before I realized that the moisture from a fairly heavy fog had condensed on the now cold motor and short circuited the plugs. Carefully drying off the top of the cylinders, wiping the connections and lighting a few drops of gasoline on each plug got things in such shape that the motor fired on two or three cylinders, and as soon as it was warmed up it ran O. K. This latch repair lasted more than a thousand miles before I could get a new latch, and looked good for several thousand more.

W. P. L., Woodlyn, Pa.

Making a New Distributer Arm

Several months ago there appeared in MoToR an article dealing with means to prevent the theft of automobiles and it was stated in effect, that the removal of the distributer arm was one of the most effective protections.

I have since used this precaution when leaving my car in an isolated place and believed, barring the slight probability of a distributer arm being in the possession of the would-be thief that it was unbeatable.

Recently, however, after removing the arm I emerged from the woods to my car and found I had lost the arm distributer. Before starting on a long hike to town, I decided to try my luck with the materials at hand.

The system was a Connecticut and with the use of no other tool than a jack knife I made a new arm and was under way in about forty-five minutes. A piece two inches long was cut from a dry limb about three-quarters of an inch in diameter and the sides were whittled flat until the piece was about one-half an inch thick. With the point of the knife a hole about five-sixteenths deep was bored to receive the end of the igniter shaft and when the shaft just entered the piece was positioned as near as possible to conform to proper distribution and tapered down upon the shaft, thus forcing the shaft with its positioning notch into the wood. With the aid of a calling card the distance from the center contact on the distributer cap to the pins was taken and the wooden arm was cut to clear the pins by about one-eighth of an inch.

A piece of aluminum strip was removed from the end of the running board and after some hunting a tack was found

on the inside of the tonneau door. The strip was scored with the knife and then broken into a piece which when attached to the top of the wood arm would make contact with the carbon center and just clear the pins in rotation. A hole for receiving the tack was then bored in the aluminum, but to attach the strip so it would be close enough to the pins to allow the spark to pass and yet not strike them, presented some difficulty as this could not be determined by trial without risk of ruining the distributer. The distnce the strip should project from the end of the arm was finally accurately determined by making a knife cut across the end of the arm and inserting a small piece of card, the arm then being positioned under the cap and the engine turned over. Several small pieces of card were tried until one projecting about one-eighth inch showed it did not touch the pins, but just cleared them.

The aluminum strip was then tacked on accordingly and upon trial the engine worked perfectly.

J. F. C., Meriden, Conn.

Making a Broken Plug Serviceable

A worn timer on a motor so equipped will result in misfiring when the car is driven at any reasonable speed.

Spark plugs become shorted and fouled with the necessity of frequent changes.

With a timer in the above condition, unknowingly we attempted a 200-mile trip. We started seemingly all right, but about fifty miles out we stopped, after changing the spark plugs for the fourth time, to look over the ignition system. The timer was removed and the contact surfaces found to be in bad shape. The segments were worn below the surface of the fiber insulation. Consequently, the roller brush when revolving would pass the segments without making as firm a contact as needed to obtain a proper spark. The occasion called for some sort of improvising and we carefully removed the segments. Letter paper was cut into strips and two thicknesses placed behind each of the contact pieces.

With these shims in position and the segments screwed up the edges while somewhat uneven, were however, flush with the fiber. In our anxiety to replace the feature and test it out, the spring which holds the roller arm and forces the brush into contact with the segments was dropped or in fact, jumped loose when an effort was being made to engage the

ends in the securing holes. A careful search failed to recover it and more improvising was needed if we were to start again.

The particular spring used was a very small and light member and no wire of that needed size was at hand from which a similar one could be wound. We obtained a small safety pin from one of the party. The point and fastener were cut off and th ends bent to hook into the holes in the brush arm and fixed bracket. With the paper shims behind the segments and the "safety pin" spring holding the brush out the timer when assembled worked satisfactorily, no further ignition difficulties being experienced on the trip.

On another occasion when the only spare spark plug was out of commission and the porcelain of one of those in the engine cracked at the packing nut, refusing to fire, we obtained further service by resorting to the following repair:

The firing pin in the center of the porcelain was removed and the "terminal" end of the broken porcelain discarded. The rough surface of the remaining part of the porcelain was flushed off smooth with a file.

By assembling the center pin upside down in this part of the insulator and packing some layers of tire tape into the "petticoat" or open end of the porcelain, the washer and nut when replaced secured the parts firmly together. The inverted porcelain was assembled in the shell and with the gaskets in place, the packing nut was tightened down. When screwed into the cylinder and the motor started it fired faultlessly.

Ten miles further we reached a repair shop and though the motor was responding on all cylinders we were not taking any chances—we laid in a supply of plugs.

G. A. Luers, Washington, D. C.

Ingenuity and a Blacksmith

While on a tour recently I had an opportunity to exercise my ingenuity in repairing an unusual breakdown in my ignition system. Fortunately I was only a short distance from a small village, and a friendly motorist towed me to the small blacksmith shop which is a part of every town. I went over the ignition system carefully, principally the wiring. But when the distributor cover was removed I found that a small section of the teeth of the gear wheel carrying the distributor brush had been stripped off, which, of course, stopped the motor.

This magneto makes use of a small gear on the main shaft to drive a larger gear on which is mounted the distributor brush. A set screw had worked loose and fell in the train of the gears and had stripped a section of the teeth of the distributor gear before dropping out. The driving gear was scarcely damaged, as it was of hardened steel, while the other was of a brass composition and much softer. I had two alternatives, either effect a repair or wait perhaps a week for a new part, which would necessitate giving up the trip. As the repair did not seem to be a very difficult one, I chose the former alternative, and with the aid of the blacksmith I set to work.

The distributor gear was removed and the damaged section cut out and filed square. This gear was provided with a shoulder, in which the teeth were cut. A piece of steel the thickness of the shoulder was secured, which was cut and dressed to fit in the cut out section. The piece of steel was then clamped with the gear wheel in order to use the good teeth as a guide. Teeth were cut in the steel piece with a three-cornered file. Great accuracy was required, otherwise the timing of the magneto would not remain correct.

In order to provide a solid foundation for the purpose of securing the assembly together it was necessary to fit additional pieces of steel on either side of the gear piece; in order to bring the entire section on a level with th shoulder. A thin piece of steel was then laid over the whole assembly. Holes were drilled and tapped and set screws run in. There was no particular need for great strength, as there is comparatively little strain on this gear.

The gear was replaced and the magneto retimed, after which the motor was run five minutes. The timing marks were again examined and found to correspond on both gear wheels. The job proved entirely satisfactory and permitted the trip to be continued with but a few hours' delay. All that was necessary was a little ingenuity and the very limited co-operation of a village artisan.

N. A. S. ,Cumberland, Md.

Punctured Magneto Condenser

If the storage battery has become too weak to start the motor, it is much easier to spin the motor, with the starting crank, if someone holds down the starting pedal while the motor is being cranked. Even though the battery is very

weak, there is usually enough current to help over the hard spots when cranking.

If there is another car available, either on the road or in the garage, the current from one car can often be used to start the other. Care must be taken that the storage batteries have the same number of cells. Heavy wires must be used to convey the starting current from one car to the other, although, for temporary use, they need not be as heavy as the wires regularly used.

Once, when the motor began to misfire, I found that the condenser of the magneto had become punctured. This was made evident by the sparking at the contact breaker of the magneto when the motor was cranked. As repairing a condenser must be done at the factory, I simply took out all the spark plugs and bent the points very closely together. This enabled the rather weak current from the magneto to jump the gaps and the motor ran fairly well until home was reached. This same principle, of closer spark plug points, can be used with a battery ignition system if the coil or condenser becomes punctured, so that the spark plug is very weak.

MURRAY FAHNESTOCK, Pittsburgh, Pa.

IGNITION TROUBLES

SHOULD misfiring occur, due to fault in the magnet, if that type of ignition system is used, the trouble must be in one of the following places: the spark plugs, the distributor, the circuit breaker, the coil, or the wiring.

The simplest procedure is to begin at one end or the other of the system and take up the series of tests in regular order. Beginning first with the plugs: If these are clean, the porcelain uninjured, and firing points properly adjusted, they can be passed over quickly, with the decision that the trouble is not there. But a crack of the width of a hair in the porcelain will cause misfiring in that plug The remedy is to discard the plug entirely, or provide a new part. By opening the pet cocks, one by one, a missing cylinder, due to a faulty plug, is quickly found.

Proceeding back along the line, taking care to examine wiring and connections, we next open the distributor case of the magneto. Trouble here is due to loose wire and connections, loose spring contact, and also to collected grease and vapor on spark gap points. It is removed by tightening connections or contact spring, or wiping the spark gap joints with a clean, dry cloth, as the case may be.

The next step is to open the circuit breaker box containing

the platinum screw and spring contacts. Bad cases of misfiring are sometimes due to these points being pitted. Turn back the screw and rub a strip of emery paper a few times across the contacts, or till they are bright and smooth. Then screw them up till the opening between, when contact is broken, is no more than 1-32 and no less than 1-64 of an inch. Before leaving the circuit breaker, see that the tappet spring is not broken or weak, for it must be stiff enough to cause the make-and-break to cover with rapidity.

If the motor continues to miss, follow all wires leading from the magneto to the coil. The only thing the novice can do in this step, and the only thing that need be done, is to make sure that the wires are good and the connections secure. Binding posts, such as are commonly used on non-vibrating coils, will finally crack, and though they appear to be screwed down tight, do not hold firmly, thus allowing broken circuits and "missing" of explosions. If cracks are found in the post screws, discard and get new. Brighten up the contact ends, make the connections good, and it is very likely that your ignition troubles will end, for a great percentage of the troubles believed to be in the magneto are due to loose or faulty connections on the coil. Don't tamper with the coil itself, and if you decide upon a new form of connection, be careful not to insert screws long enough to penetrate box cover, otherwise the coil will be ruined. It is presumed that this step includes also the examination of the switch and its connections and contacts, which can only cause trouble by getting loose.

If the trouble still manifests itself, it must then be located in the current supply. The important things with the battery, aside from having it "alive," are secure connections. If dry cells are used, test them out one by one. Discard every cell that falls below 7 amperes. If a storage battery is employed, see that the pole connections are not corroded, then test it out with a hydrometer. Just a little cup grease rubbed on these terminals before screwing the connections down will prevent corrosion. Where a magneto is installed and the battery is needed only for starting the motor, if the engine runs right on the latter, it can be decided that trouble is in the magneto. But with this series of tests fully made there is bare chance of trouble being found in the magneto. If so, it is located generally by placing a screwdriver on the magneto to learn if they still retain their "pull." Only at rare intervals do these lose their magnetism, and when this occurs the safe plan is to return the magneto entire to the makers for repairs. Sometimes a slight end play of the armature causes misfiring. This is remedied by inserting a copper washer between the collar and end plate. A worn bearing at the end of the armature

spindle will allow the current to "jump," and is remedied by replacing with a new one.

This will have completed the tests, provided the wiring is examined carefully as the examination proceeds; and it should result in trouble being located. Some would prefer to begin first with the current supply and work toward the engine. That is well, provided the steps in the series are followed in regular order. The thing to avoid is jumping haphazard into the middle, or into any point between the two extremes, for to do this leads to confusion, and generally fails of results.

DENNIS H. STOVALL, Gran't Pass, Ore.

External Sparks

The best way to locate the causes of ignition trouble is to proceed systematically by a process of elimination. Cut the system into two parts, so to speak, finding out in which one the trouble is located; and then subdivide this until the fault is located in some one spot. Ignition trouble may be divided into two causes: (1) the engine will either cease to fire regularly and develop trouble common to all cylinders; or (2) the trouble will be with the sparking of some one cylinder.

In the first case the trouble will probably be in the wiring common to all cylinders, most likely in the primary or low-tension circuit. In such cases, first inspect the current source, testing the battery with a meter and examining all its connections and terminals. Then examine the ground wire, making sure all contacts are good and connections tight. In the same way examine the wire running to the switch, the switch itself, and see that all connections of the coil are tight.

If the trouble is that one of the cylinders will not fire, the fault may usually be located in the secondary or high tension circuit. To locate the cylinder whose ignition is at fault, open the pet-cocks while the engine is running. Hold the hand near the cocks and the cylinder which is not firing can be quickly located by the weakness of the puffs of vapor issuing from it, as well as by its lesser noise. If there are no pet-cocks, the missing cylinder may be located by disconnecting the leads to the plugs if a magneto is used. Run the engine on one cylinder, changing about until the weakest cylinder is found. If vibrator coils are used, adjust the trembler of the cylinder whose ignition is faulty. If this does not cure the trouble, disconnect the high-tension lead from the spark plug of this cylinder and hold about one-fourth of an inch from the cylinder wall. If there is a good spark when the distributor is on contact, the trouble is with the spark plug. If there is still no spark replace the spark plug connection and

uncouple the same lead at the coil or distributor, as the case may be. If a good spark can be obtained by holding the end of the lead one-fourth of an inch from the terminal from which it was uncoupled, the wire must have a hidden break or "leak" somewhere. J. T. L., Worcester, Mass.

TRACING IGNITION TROUBLES

IT is a noteworthy fact that the modern high-tension magneto being once properly adjusted requires but little, if any, attention.

If properly protected from dirt, oil or water, and given a few drops of oil about once a month its owner will experience the gratification of perfect ignition for a season or more.

"Don't tamper with the workings of a magneto" is good advice to follow, nevertheless there are certain things which may happen to the best magneto, easily remedied even by the amateur. First be sure that the magneto is really at fault. If one cylinder gets a hot spark something is probably wrong with the other cylinders or wires leading thereto. If one of the distributor terminals gets a spark the others do also almost certainly.

Next eliminate broken or disconnected plug wire, fouled or broken plug or plug unsuited to magneto, improper adjustment of plug points, corroded or improper connection of cable to magneto (should be clean, bright and tight), oil-soaked, short-circuited cable, short circuit in cable switch—no spark. Remember, too, that carbureter, valve and other engine troubles (leaks, lost compression, etc.) may stimulate faulty ignition so as to be almost indistinguishable.

This elimination indicates that contact is probably not being properly made at one or more points in the distributor on the magneto. See that one or more of the carbon brushes are not stuck or broken or its spring weakened or lost through the distributor lid having become loose. A space of 1-32 inch between segment and distributing points is normal in some magnetos as current jumps the gap.

Either no spark or very weak: The distributor may be wet or short-circuited by oil or dirt—remove lid, wipe out clean and dry.

The collector brush may not be making proper contact with distributor segment; see that it is not stuck or broken. (Close contact not necessary.)

Safety gap may be too short and allow the current to pass here rather than at the spark plugs, especially during damp weather.

The field magnets may be losing their magnetism, which would cause misfiring at low speeds.

There may be faulty adjustment of the circuit breaker, due to loose adjusting screw, worn points, or worn cam. The platinum points should have a smooth surface and be free from dirt or scale, best produced with fine emery cloth or very fine jeweler's file. Follow instruction book as to proper adjustment of breaker gap, usually 1-50 inch to 1-32 inch, or about the thickness of a calling card.

If the cam is much worn any attempt to properly adjust the breaker gap results in displacing the break relative to armature position. The break should occur at the moment of greatest current wave to secure the most effective spark. Obviously, the break cannot thus occur with a worn cam and the remedy is a new one.

This relation of breaking time to armature position explains why it is necessary in some magnetos to increase the break gap slightly if motor misses with spark retarded at slow speed, or vice versa, to decrease the break gap if motor misses at high speed with the spark advanced.

Entire absence of current may be caused by sudden loss of magnetism, or disconnection of magneto from driving shaft, sheared gears or lost pin or key. A short circuit between armature or coil secondary and distributor, a broken-down condenser, or secondary winding, are extremely unlikely to occur in a modern ignition system.

If, in replacing the magneto after it has been disconnected from its driving-shaft (unadvisedly in most cases) the motor will not run even though sparks are obtained at the plugs, it is probable that the armature shaft has not been turned to proper position in relation to position of pistons in the cylinders. Remedy: Get one cylinder ready to fire. See that distributor segment is over proper point for that cylinder, then set gears so that break occurs. W. R. I., Tucson, Arizona.

Keep It Clean and Dry

The average high-tension magneto, when in good order, requires very little attention. Keep it free from dirt, water and oil, and keep its wiring clean and out of contact with any of the metal parts of the car, letting it have as few sharp bends as possible. All terminals must be drawn up tight, in order to make good electrical connections. A drop or two of oil every 1,000 miles or so, in the magneto oil holes, is all the lubrication necessary, and the breaker box must on no account be oiled. Occasionally remove the cover of the latter, and slip a piece of fine emery cloth between the platinum contact points. Then gently press them together and draw out the cloth. After repeating this operation till the points are clean, adjust them to between 1-32 and 1-64 of an inch.

In the case of defective ignition the fault may be found by the following process of elimination: When the motor misses on one cylinder only, the trouble is almost certain to be in the high-tension circuit, if the carbureter adjustment is correct, and the cylinder itself is in good order. Examine the spark plug of the defective cylinder. In a porcelain plug the insulator may be cracked; the disks of a mica plug are liable to become loose. Again, the spark may be too wide or too narrow (1-32 to 1-64 of an inch is correct), or the plug is perhaps sooted. If none of these faults is evident, examine the high tension wire. A break may be detected by bending the wire slightly, all along its length. The broken part will bend more easily than any other. If the cause still remains undiscovered, remove the distributor cap in order to see if the brush and collectors are in good order. Also see that the terminals are not loose. Sometimes, in a magneto whose distributor brush is pressed by a spring against the collector ring, the latter may be short-circuited by particles of metal or carbon which have been rubbed upon the insulator by the brush, as it revolved. If this is the case, a rag will remove the difficulty.

When the engine misses irregularly on all cylinders examine and clean the plugs, and see that the wiring is proper, and in good condition. If spitting and backfiring accompany misfiring, and the trouble is not in the carbureter, two or more high-tension wires may have been incorrectly replaced. If not, examine the distributor as above, and also note whether its brush is electrically connected with the high-tension collector. Next remove the latter, and make sure that it is in good shape, and that it presses against the collector ring on the armature shaft.

In case all this fails to bring the source of trouble to light, the armature winding or the condenser may be punctured, or the magnets may perhaps have lost their strength. The magneto should be returned to the maker for repairs, and should on no account be left with any small electrical concern.

Roy Wood, Toronto, Can.

CHAPTER III

CARBURETION AND FUEL FEED SYSTEMS

REGULATING THE FLUID SUPPLY

IN practically all modern carbureters there is only one or more nozzles for feeding the gasoline. Bear in mind in making adjustments that either air or gasoline flow may be controlled, except in cases where fixed non-adjustable nozzles are used, as in the case of the Zenith. When any adjustment is made to a fuel nozzle there is a corresponding change in the amount of air drawn in. In other words, if you decrease the fuel opening you automatically allow a little more air to be sucked in, in proportion. Likewise if you adjust an air opening you automatically change the amount of gasoline in the mixture.

Starting with the assumption that the carbureter is in such shape as to permit of running the engine, and that the ignition system is in ordinarily good working order, there are several means available to determine whether or not mixture proportions are correct. If the carbureter is of the float-feed automatic type, with spring air valve, a slight opening of the valve beyond its position as normally determined by the engine suction will serve at once to indicate whether more fuel or more air should be supplied. If the air valve is in an accessible position or if the engine suction causes it to flutter, the float valve can be manipulated with the same end in view. In this latter case the float valve can either be raised slightly, or its action somewhat dampened by holding the finger or the stem of a match lightly against it. This latter will cause the admission of somewhat more fuel than is normally supplied and will slightly enrich the mixture, while an increased opening of the air valve will cause the mixture to become poorer in fuel.

It is well known that an engine will run most rapidly under any one set of conditions when the mixture proportions are just right. This being the case, the engine will speed up under the air valve test if the mixture is normally rich, and will slow down if the normal mixture is just right or a trifle thin. Under the float valve test, which is probably the more sensitive of the two. the engine will increase its speed if the mix-

ture is normally weak, and will run slower if the normal mixture is correct or is already overrich. The point of correct setting can be determined by slightly shifting the nozzle outlet adjustment until the latter symptom of decrease in speed under the float valve test is apparent only after the lag has been applied to the protruding valve stem for some few seconds. Of course, one can at once begin shifting the nozzle and air valve adjustments about, but this method is not conducive to as quick location and elimination of faults.

Having determined that the mixture proportions are at fault, the thing to do is to proceed to make the adjustment as nearly perfect as conditions will permit. As a general thing, the float valve adjustment, determining the level of the fuel in the supply chamber, can be left religiously alone, unless, of course, flooding occurs. Wear of the parts operating the float valve can under no circumstances cause the level in the float chamber to lower—a thing to be remembered. If the engine displays more or less impoverishment, increasing as the speed increases, it should be determined whether or not the supply line to the carbureter is free. This can be done by opening the float chamber drain cock, after setting a can beneath it, and noting the rate of flow after it has been opened sufficiently long to drain all reserve supply from the chamber. This flow should be a steady stream of about the diameter of an ordinary match stem; if the flow is materially less than this the line should be inspected.

With sufficient fuel being supplied to the float chamber, it is well to determine the condition of the nozzle outlet. Most nozzles are provided with a needle valve adjustment. Remove the needle valve and examine its tapered end, and carefully remove any serrations or score marks that have been caused by forcing it onto its seat. Since the nozzle adjustment is usually a very fine one, perfect smoothness and truth of the surfaces must be had if one is to be able to make a close setting. With the nozzle parts in good condition it is a simple matter satisfactorily to make this setting. Since the average modern carbureter is very nearly, if not exactly, automatic in its action, this setting can be made with the motor running light. Set the nozzle adjustment so that the engine runs at its fastest for any given position of the throttle.

In the air valve spring lies the chief difficulty in making carbureter adjustments. This spring should be of such length and of such gauge wire, diameter and number of convolutions as to provide the requisite progressively increasing resistance to opening, while at the same time exerting little or no pressure upon the valve when it is against its seat. The nozzle

should be set for slowest running with the air valve held firmly against its seat, and then the spring adjustment should be backed off until the slightest further increase in throttle opening causes the valve to leave its seat. From this point on the only proper adjustment for the air valve becomes a series of tests for spring strength without alterations being made in its normal length. That is, with the adjustment backed off as per the above instructions, if the spring tension with increased throttle openings is too light, parts of or whole convolutions should be cut off, and the spring stretched to just the right length to hold the valve upon its seat until the correct *spring* (not spring tension) is had. If the spring already fitted appears too strong under this treatment it can be unwound slightly to increase the diameter of the convolutions, until it has been made correct. This method gives one a correct spring and leaves the usual adjustment free for the purpose of taking up as necessary because of weakening of the spring due to its loss of elasticity with age.

T. P. STUART, New York City.

A Series of Simple Tests

Faulty carbureter adjustment may have either of two ill effects on the mixture fed to the engine: it will either contain too great a percentage of air or not enough. If the mixture is much too rich, black smoke may be seen issuing from the exhaust pipe. Care should be taken to distinguish this from the blue smoke which indicates too much engine lubrication. In both cases the engine may also miss due to fouled spark plugs. If the mixture is too rich, the engine will have a tendency to slow up and "choke" when the throttle is partly closed.

Another indication of the mixture being too rich is the fact that the engine will be speeded up perceptibly if the air valve of the carbureter be held open, or if the air be admitted between the carbureter and engine. If the mixture is too weak this may be indicated by "back firing" or popping into the carbureter. Both this and explosions in the muffler may indicate faulty ignition, however. If the mixture is too weak the engine will be speeded up by reducing the amount of air admitted to the carbureter, and will slow down or stop if the proportion of air in the mixture be increased. It may be speeded up by squirting gasoline into the carbureter through the air inlet.

The best way to adjust a carbureter is to have the engine run under load while the adjustment is being made. To adjust the average automatic carbureter, probably the best way is to first run the engine well loaded, but at what will be nearly its

maximum speed on the road, with the throttle open but the spark rather late. This speed, of course, will be considerably less than the maximum speed of the engine when running idle. Begin by rning the main gasoline adjustment until the mixture becomes so weak that there is popping in the carburetor. Note this adjustment and then turn until the mixture is so rich that the engine chokes and threatens to stop. Then set the adjustment about half way between the two, which will be very near the desired point. Try turning slightly, first in one direction and then in the other, and set the adjustment at whatever point the engine seems to develop the most power and runs the fastest. Then gently and gradually cover the air inlet of the carbureter, placing the hands over the valve if necessary, in order to exclude the air. If the engine slows down, the amount of air should be increased, since not enough air is allowed to enter the carbureter. If the engine speeds up, however, the mixture is too weak. Next, try giving more air. If the engine speeds up there is not enough air, while if it slows down there is too much air. After the air inlets have been adjusted, open the throttle again and run at high speed for the second time, as the adjustment may now be somewhat different at high speeds.

J. T. L., Worcester, Mass.

THE HOT JACKETED CARBURETER

THE function of the carbureter is to convert liquid gasoline into vapor, and to mingle the vapor with air in certain proportions. For this, two things are primarily needed; evaporating surface and heat. If the gasoline is thoroughly atomized the surface is that of the minute liquid particles, and is greater as the particles are more finely subdivided. The heat necessary for evaporating is in this case supplied by the air itself. If, on the other hand, the gasoline touches the walls of the mixing chamber and induction pipe it will probably cling, though swept along by the air current, till evaporated or till it enters the engine in liquid form. This may occur by intention, as with the puddle type of carbureter, or without intention in the spraying type, through the spray being deflected against the wall by the partly closed throttle or otherwise. In such case the heat for evaporation must be derived largely from the metal surfaces. If the air is heated, only part of the heat is likely to be used in evaporating the gasoline, and the remainder expands and rarefies the charge, which is undesirable.

In most carbureters evaporation takes place by combustion of the above actions—atomizing in the air and wall-contact evaporation. The hot jacket contributes a little to help the wall-contact evaporation, but its chief usefulness is to pre-

vent the intense cold due to spray evaporation near the nozzle from congealing the moisture in the air, and thereby causing the carbureter to "freeze up." The evaporating action would be greatly assisted if the induction pipe were hot-jacketed for some distance above the carbureter. To avoid undue rarefaction of the charge, the air could then be taken in colder than would otherwise be possible.

HERBERT T. TOWLE, New York City.

Vaporization by Pressure Drop

Vaporization is effected by a reduction in pressure or by the application of heat to the fuel. That part of the fuel which vaporizes through pressure reduction does so through the abstraction of heat from the remainder. That part which vaporizes through the application of heat does so through the abstraction of heat from the surrounding air and carbureter passages. If the nozzle delivers a true mist spray no hot jacketing will be required. However, if the division is coarse, the fuel will be spread over the walls of the passages and a hot jacketing will be necessary. The latter conditions obtain in nearly all carbureters at low engine demands, observation through transparent mixing chambers disclosing the fact that the fuel leaves the nozzle in a solid stream or in large globules. These globules must be vaporized before reaching the engine, or the mixture will be stratified. The mixture from a jacketed carbureter is undoubtedly better under ordinary circumstances, and the greater the heat supplied the better will be the mixture. Much can be urged in favor of high charge velocities, which result in greater pressure drop and more rapid agitation of the mixture, but constant high charge velocities may only be secured through the multiple jet.

J. C. CARPENTER, Houston, Tex.

Refrigeration Must Be Compensated for

In considering this question we have to deal with the results obtained by applying heat to the carbureter walls through a water jacket, as opposed to a carbureter unheated except as it is located close to the engine cylinder or is provided with a warm air supply.

The action of the spray nozzle in a carbureter is similar to that of an ammonia expansion valve in an ice machine. There is a considerable reduction in temperature in the carbureter, really an expansion chamber, but not so called. An unheated carbureter sweats and in some cases is covered with frost. Even then a good mechanical mixture is often obtained, but

invariably a portion of the gasoline suspended in the air is deposited on the manifold walls before the hot combustion chambers are reached. Aside from the correct proportion of air and gasoline, the best mixture should be as near a vapor of true gas as possible. Consequently some heat must be applied to the vaporizing chamber. The best method is to uniformly heat the carbureter walls with hot jacket water, thereby supplying the engine with a temperate vapor, instead of a refrigerated mixture which may be power producing but is uneconomical, or a hot blast mixture that is economical but weak. M. F. Bates, Dayton, Ohio.

The Jacketed Carbureter

In the typical carbureter, vaporization is accompanied by the abstraction of heat from the surrounding air, the fuel and the passage walls, and these must be maintained at or above a certain temperature, else vaporization will not be sufficiently rapid or will cease.

The vacuum, or pressure reduction, which accompanies the cranking of the motor, is so slight as to have little effect on vaporization of the fuel, and it is customary to close the air port by a valve in order to increase the vacuum about the nozzle and thereby have more fuel available for vaporization Even then the fuel leaves the nozzle as a liquid, and almost all of it persists in that form. If the fuel division at the nozzle were fairly fine, a pre-heating of the initial air would suffice, but, since the fuel division must necessarily be coarse, a stream of fuel will be spread along the walls of the carbureter and intake manifold, and a heating of the walls will be the better method. This is accomplished in various ways: by the application of cloths wrung out of hot water, by pouring gasoline into the cylinders or into the intake manifold, and by other and less simple methods. I have devised a method which is not only safe and efficient, but very convenient.

Using a water-jacketed carbureter, I place inter-connected three-way valves in the circulating system, both above and below the carbureter. From the third leg of the upper three-way valve I have carried a copper coil upward around the induction pipe and placed a small funnel at the top of this coil. Both three-way valves being linked and operating together, the circulating system of the carbureter may be disconnected from that of the engine, and hot water may be poured into the funnel, passing thence through the coil and the carbureter jacket, heating both the induction pipe and the mixing chamber. As soon as the water comes warm from the lower valve prime the carbureter and crank the motor.

In case the carbureter is heated from the exhaust, there will be no necessity for the lower valve. In either case the valve or valves may be operated from the dash, and at higher speeds and throttle demands the carbureter may be cut out of the circulating system if it is found that more power is had in that way. J. C. CARPENTER, Houston, Tex.

BACK FIRING IN THE CARBURETER

A SLOW burning charge is the cause of backfiring into the intake manifold and carbureter, fire remaining in the cylinder through the exhaust stroke and igniting the gas in the manifold at the opening of the intake valve. This slow burning charge is usually lean, lacking in gasoline, the air predominating and separating the particles of gasoline so greatly that the flame has difficulty in "jumping the spaces," doing so slowly and prolonging the time of combustion.

The remedy lies, of course, in obtaining a better mixture, and the seat of the trouble is the carbureter, which is admitting too much air, or not enough gasoline. The spring of the air valve should be tightened, or its amount of opening lessened, which will cut down the air. In case the carbureter suddenly develops such a disability to deliver a proper mixture, and the air valve seems as usual, it is well to inspect the needle valve, which may be partially stopped up, or the nut on the needle stem may have become loose and allowed the needle to work down.

If the trouble does not seem to be with the carbureter, inspect the intake manifold. Sections of gasket have been known to drop out, admitting air, and the manifold to become loose on its studs. The latter will, of course, be noticed as soon as the carbureter is touched.

An over-rich mixture is another cause of backfiring into the carbureter, though not as common as the lean mixture. Gasoline predominates, and the flame has a hard time finding enough oxygen, with the result that, as in the former case, flame is left in the cylinder when the intake valve opens, and ignites the incoming charge back through the intake manifold to the carbureter.

Another and still less common cause is carbon deposit. A projecting point of carbon in the cylinder becomes red hot, and retains its heat through the exhaust stroke, igniting the incoming charge. Backfiring through the carbureter from this cause is always preceded by violent and characteristic pre-ignition knocking, the point of carbon at first not being hot enough to ignite the mixture until it is compressed. After the motor has run long enough with this pre-ignition the carbon becomes

hot enough to ignite the charge as it comes in. The remedy is, obviously, remove the carbon, by either chemical or mechanical means. S. W. Seley, W. Philadelphia, Pa.

"Lean Mixture"

Incomplete combustion caused by an impoverished mixture is that condition which causes a motor to backfire into the intake pipe and carbureter.

The mixture may be impoverished by a carbureter adjustment admitting a surplus of air, in some cases only at the higher motor speeds, or by leakage at some one or all of the joints between the carbureter and cylinders. It may also be impoverished by admitting an insufficient supply of gasoline past the needle valve with correct air adjustment.

As an impoverished mixture, otherwise known as a lean mixture, burns slowly and spasmodically, owing to the excessive amount of oxygen present necessary for the combustion of the charge, there is at times a portion of it still burning at the end of the exhaust stroke, and as the inlet valve opens it fires the gas contained in the intake pipe and carbureter, because of the fact that this gas is moving towards the cylinders at a slower rate of travel than that of the flame propagation; but as this does not happen at every intake opening, the next inspiration stroke or one closely following it again starts the flow of gas through the carbureter, and puts the engine in operation until the same thing occurs again.

I have also known of cases where carbon deposits becoming incandescent have ignited the gas during the inspiration stroke and caused the same action.

Frank Kelty Green, Salem, N. J.

Cause of Fire

Backfiring to the carbureter is a dangerous disorder, for it is a possible source of fire. For this reason, if for no other, it should be eradicated at the earliest opportunity. One of its most common causes is weak mixture. The rate of flame propagation in such a charge is comparatively slow, for the excess of air over and above that necessary for complete combustion is not only useless but is a great hindrance to the latter. It dilutes the mixture unnecessarily, and absorbs a good deal of the heat liberated by the fuel. Under such conditions the charge may still be burning when the inlet opens. This will probably ignite the fresh mixture, with the result that the flame will shoot back through the manifold to the carbureter. This tendency to backfire is at its height when the motor is running with a retarded spark, for then ignition

takes place later in the cycle, and hence the combustion will not be completed until a correspondingly later period. When a weak mixture is the cause of backfiring, the latter is generally accompanied by occasional missing in the engine. The obvious remedy for this is carbureter adjustment, which can be easily effected. Before doing so, however, it would be well to see that the inlet pipe has no flaws, and is perfectly gas-tight at its connections, in order that each cylinder will receive a uniform mixture.

Another fruitful source of trouble is carbon deposit in the cylinders. This is largely due to excess of gasoline, and here, again, carbureter adjustment is necessary. Carbon forms a paste with cylinder oil, which hardens on the walls of the combustion chamber. The rough, uneven surface of this coating occasionally becomes incandescent, thereby igniting the incoming charge, which consequently burns back through the manifold.

Backfiring may sometimes be traced to leaky inlet valves. However, this disorder is rare, for the latter are not so liable to pitting, parping or carbonizing as are those of the exhaust. A leaky valve forms a passage between the cylinder and inlet manifold, and consequently flame may blow through it into the mixture. Valves should be tested for leaks by removing the valve caps and placing a little kerosene around their seats.

Roy Wood, Toronto, Canada.

Variety of Causes

The "popping" in carbureters may be attributed to four special causes, namely: 1, the mixture; 2, leaks; 3, valve timing; 4, ignition timing.

1. (a) A weak mixture is the common source of "popping" in carbureters, and the cause of probably nine-tenths of it. The carbureter may deliver a good mixture at slow engine speed, but when engine is suddenly speeded up the action of the auxiliary air valve is too great for the amount of gasoline sprayed, and a popping in carburetor results from the weak mixture. A tightening of the auxiliary air valve spring (thus reducing the quantity of air) will remedy this. The same action may be realized by running car slowly under load o high gear with wide-open throttle, and may be remedied by lessening the air supply. Anything that hinders the flow of gasoline through the needle valve will make a weak mixture and cause popping, such as water in the carbureter, needle valve partially stopped, gasoline level in carbureter too low, a poor grade of fuel, or upon starting engine in cold weather when the gasoline is slow to vaporize. Sometimes a water

jacketed carbureter will give weak mixture until it is heated by the circulating water. (b) A too rich mixture, however, may burn so slowly that when inlet valve opens the flame is still in the cylinder, and fires gas in manifold, when inlet valve is opening for a fresh charge.

2. (a) Leaks in manifold or carbureter connections to manifold will make the mixture weak and are very annoying and hard to find, especially if these are in the form of cracks or flaws in manifold or gaskets. A very close examination for leaks will repay the trouble. Gasoline may be squirted from an ordinary oil can upon suspicious joints or places around manifold, and a leak will slow down motor on account of a too rich mixture, but if the motor is receiving a very clean mixture it may speed up motor temporarily. (b) A bad leak in the exhaust valve of one cylinder will cause that cylinder to fire from the exhaust of the adjacent cylinder; that is, if both cylinders exhaust in the same chamber, and if its inlet valve is open it will backfire in carbureter.

3. (a) An exhaust valve may be so out of time that it will not seat, the action being the same as 2 (b). (b) The inlet valve spring, if too weak will not seat valve properly or valve may leak badly, or the stem may be gummed up so that it closes sluggishly, or valve may not close in time; any of these will allow the flame to pass into the manifold and backfire in carbureter.

4. (a) The ignition, when occurring too late, may cause the gas to be still burning when inlet valve opens the same as in 1 (b). Also a weak spark will take longer to ignite and burn the gas than a hot spark, and the charge in cylinder will be slow in attaining its height. (b) A ground caused by loose wire or frayed ends may cause spark to occur in cylinder at any time during its cycle. A weak mixture burns with much more rapidity than a proper mixture, and ignites very easily, but when compressed it will not fire.

ROBERT L. WHITCOMB, Evergreen, Ala.

ON THROTTLE OPENING

GIVEN a perfect, automatically compensating carbureter, correctly adjusted, to continue with wide-open throttle would be proper when the motor slows down on the hill. No carbureter has, as yet, reached perfection. For that reason, in such events, an improvement in motor action is obtained quite frequently, if not sufficiently often to make the rule by a manipulation of the throttle, the best position being found by the "feel."

When the motor slows down on a hill, the velocity of inrush-

ing air is decreased, thus raising the pressure at the gasoline nozzle to a closer balance with the atmosphere pressure on the gasoline in the float chamber. Less liquid is thereby forced into the air stream with a resulting "starved" mixture and weakened power.

Compensating devices are designed with a view to keep the mixture constant at all motor speeds, by regulating the velocity of the air, or pressure reduction at the nozzle, so that the correct quantity of gasoline will be injected to make a perfect mixture. Many perform very satisfactorily, but it is evidently very difficult to design a simple yet sufficiently sensitive device to compensate perfectly when the motor is drawing a large volume of air at high velocity, and then a much lesser volume at a much lower velocity through the same size orifice. It is the failure of the carbureter to perform this compensation that makes it possible for the operator to improve the mixture and pulling power of the motor by partially closing the throttle.

In closing the throttle, a change is effected in various ways, governed by the design of the carbureter. A less proportionate amount of air passes through the auxiliary port; the throttle closing near the nozzle chokes the air stream and increases the velocity and homogeneity of the mixture.

Should the operator be driving with a rich mixture at high motor speed, as so many are apt to do, then as the motor slows down on the hill, if the throttle is kept wide open, the mixture will, in many cases, gradually improve and give better results than will be had by manipulating the throttle.

M. J. Roseboro, Denver, Colo.

Altered Pressure Conditions

After a car has started to slow down when climbing a hill the engine will deliver a little more power if the throttle is slightly closed. The carbureter is responsible for this apparent paradox, and its action may be explained as follows:

The ordinary or usual type of carbureter used on gasoline engines to-day depends upon the vacuum produced over the gasoline nozzle by the engine suction for drawing and mixing the gasoline into the air as it passes to the cylinders. Automatic means are usually provided for maintaining the proper ratio of gasoline and air throughout different ranges of engine speed. Such a carbureter properly adjusted will give an engine a correct mixture at maximum speed with the throttle wide open. If the engine is slowed down considerably without closing the throttle, the mixture becomes weak because of the fact that the lessened speed of the indrawn air produces less

vacuum at the gasoline nozzle, and this results in less power. Closing the throttle slightly will reduce the amount of air drawn through the auxiliary part without materially affecting the vacuum at the gasoline nozzle, and gives a more nearly correct mixture for maximum power at this reduced speed.

When climbing a long, steep grade on high gear, the throttle should be gradually closed as the car slows down. If the speed still continues to diminish a lower gear must be used, and the throttle should be again opened.

W. O. Lum, Amsterdam, N. Y.

Spark Position and Throttle Opening

In order to get the greatest power from a motor at any given speed, it is necessary that we get full charges of mixture into the cylinders, that this mixture be properly proportioned and that it be ignited at the correct point of the stroke. If we cannot exactly meet any of these three conditions. it may be necessary to slightly modify either or both of the other conditions. For instance, some carbureters can be depended upon to give a uniform mixture through all combinations of motor speeds and throttle openings. In this case, if the ignition is properly timed, it is best to fully open the throttle when the motor starts to slow down, for, although nothing may be gained from it at the time if the speed of the motor is such that full charges are going to the cylinders with partially opened throttle, yet, in case of some lightening of the load through a change of road conditions, the motor may then have a better chance to pick up speed. On the other hand, there are carbureters which are so constructed that with full throttle opening at low speeds the mixture is very much weakened. With this type of carbureter it is possible to stall the motor by opening the throttle too suddenly, particularly when the motor is turning over slowly under light load. With a similar type of carbureter it may happen that although the throttle is partially closed, so that only partial charges go to the cylinders, the quality of the charges will be so much better than that of the full charge that better all-around results are obtained.

Just what setting of the throttle is best under any conditions can only be learned for a given machine by experiment, and the realization of this fact will go quite a little way toward making one a good driver. In some machines fitted with either fixed or automatically advanced spark it may happen that the timing of the spark is too far advanced at low motor speeds for full charges under such a condition, even with a correctly proportioned mixture, the motor may

be working against itself. In this case better results may be obtained with a partially closed throttle than with a fully opened one. H. H. BROWN, Boston, Mass.

Relieve the Nozzle Chamber

If the carbureter used is correctly designed and properly adjusted to give a perfectly correct mixture of gasoline and air for all engine speeds, no better pull will be obtained from the engine by partially closing the throttle when the engine slows down on a hill. On the contrary, under these ideal conditions a throttling of the incoming charge will tend to decrease the pull of the engine and cause it to slow down still more.

It is true that a great many of the carbureters on the market when adjusted for normal engine speeds do not give equally good results at higher or lower speeds. With one of these carbureters it may be advisable to relieve the vaporizing nozzle chamber of the sudden inrush of air caused by a quick opening inlet valve with full throttle.

This relief may, in a measure, be accomplished by partially closing the throttle and thus concentrating these spasmodic drops in pressure, due to the restricted passages, to the vicinity of the throttle rather than to have them distributed throughout the intake system. No definite answer can be given to this question, since different makes of cars and carbureters behave differently and therefore require different treatment, adjustment and control. RECIPRO, Buffalo, N. Y.

A Matter of Adjustment

When a car is running at very moderate speed the engine may pull better by partially closing the throttle, but if it does it indicates that a good mixture is not being supplied, because the carbureter is either too large, is not properly adjusted, or is not of good design. The driver should try varying the fuel supply and learn whether the motor needs more, or whether it already has too much. Knowing this, he may be able to remedy the trouble.

Or, if better results are obtained by partially closing the throttle, it may be because when the car is running slowly the cylinders have time to fill to the limit and the consequent high compression does not permit the most effective spark to penetrate it, probably because of weak battery, poor coil or low magneto speed. Regularity in firing does not prove that the ignition is all right, for a poor spark will ignite the charge, but not in a way that produces the most power. With good mixture and good ignition it is impossible

to conceive of obtaining more power by decreasing the supply of explosive mixture by partially closing the throttle.

FRANK N. BLAKE, North Adams, Mass.

CONSERVING THE FUEL

OF the gas-saving devices put on the market in the past, there have been so many backed by overdrawn claims and worthless guarantees that most motorists have become rather skeptical of them. That was the writer's attitude until about two years ago, when a trial purchase of a little auxiliary air valve attachment featured by a well-known accessory firm convinced me that these devices were not all bad. This device was simply a little butterfly valve attached to the inlet manifold and operated by a convenient handle on the steering post. The car to which it was applied was a 1913 model having a medium-sized four cylinder motor which had always been rather slow in accelerating and had lacked flexibility. To secure satisfactory idling it was necessary to set the needle valve at a point which caused loading up and smoking when maximum speed and power were needed. The auxiliary air valve in the carbureter itself, although set and operating all right, according to a carbureter service man, failed to overcome this. The new air valve in the manifold corrected this condition to a marked degree. Whenever the pulling was heavy, or I wanted to explore the remote portions of the speedometer scale, I gave the conveniently notched steering post handle of this device a slight turn while opening the throttle, and found it very helpful. With the new valve there was a little less tendency to carbonize, and gasoline consumption decreased about eight per cent, which seemed good results from a $4 investment. The device required no repairs in over 6,000 miles of use.

In this general class of air valves there are two common types —one for attachment directly to or within the carbureter, and the other in or upon the intake manifold. Though having had personal experience only with the latter type, the former seems more liable to hamper carbureter operation and adjustment and more difficult to install and less accessible.

Another classification of devices for altering the proportion and atomization of air in the mixture might be made into hand-operated and automatic types, respectively. Although some motorists report satisfactory results from the automatic type, these devices are so dependent on compression, motor temperature, carbureter type and adjustment, grade of fuel, and similar variable factors that the manual type is preferable.

Many different shapes and types of air valves have been produced, some stationary (except when moved by an operating

rod), and some revolving or vibrating with the intake suction. While the latter are claimed to produce a more energetic mixing action, they are generally noisy and more liable to get out of order.

There are at present a good many steam injectors, vaporizers, and decarbonizers on the market which are claimed to save gas, increase speed and power, eliminate carbon, and make themselves otherwise generally useful. Most of these outfits utilize water, from the motor's cooling system or a small tank of their own, to join the mixture of air and gas in the inlet manifold. As the water enters the combustion chamber, it is supposed to form live steam, which prolongs the period of combustion and converts carbon into carbon monoxide gas that passes out of the cylinder on the exhaust strokes.

Whatever the theoretical pros and cons of the matter, I installed a device of this type last summer on a little four-cylinder car which was giving considerable carbureter and carbon trouble, and I have no doubt that it was worth the $5 that it cost, because it was directly responsible for smoother running, with much less carbon and slightly decreased gas consumption. Simply running the motor several minutes with the water valve of this outfit turned on was all that it was necessary to use it. By doing this regularly once in 300 miles in winter and every 200 miles in summer, I have had no serious carbon trouble in almost a year, or about 4,700 miles and have saved at least twelve gallons or about $3 worth of gasoline.

If one has a high-grade modern car and is a "stickler" for correct carbureter adjustment, lubrication and careful driving, he will hardly find it worth while to install a special air valve, vaporizer or steam injector; but my experience leads me to believe that the average owner with the average car will gain more than its cost in purchasing well known equipment of this kind.

DONALD MCCLEAN, Detroit, Mich.

Experience the Only Teacher

In common with others, I have tried many of the auxiliary devices designed to improve the performance and efficiency of an automobile, but the result was more often unsatisfactory than productive of any desirable result.

My first experience was with the so-called automatic air valves, a device screwing into the intake manifold and designed to admit air to mix with the gas charge, proportioned to the suction from the engine. The device proved of no value whatever with the carbureter properly adjusted, in fact made the mixture too lean at high speeds. By setting the carbureter at a point that secured smooth running when cold the use of the air valve increased the gasoline mileage twenty per cent, but the increased figure was

practically the same as with the carbureter set for a warm engine. The general experience was that the device is only beneficial where the carbureter is improperly adjusted.

But those devices designed to inject steam into the manifold have some real meritorious points. I have used one of those devices for over a year and still have it, although have never secured the results claimed for it. The claim is made that steam will remove carbon, but I have found this to be misleading I have never been able to find that steam injection had any noticeable effect on existing formations, but once cleaned the continuous injection of steam will keep the engine practically free from carbon. The only way to use a device of this character is to clean the engine, then install it and the engine will be kept in good trim for a long time. The injection of steam will slightly raise the maximum compresson and give a quick-firing mixture and a snappier engine. In this respect you can liken the results obtained from steam injection to the noticeably improved engine performance in the evening or immediately preceding a rain storm.

I have also tried a few of the many gasoline energizers. What good there was in any of them was more than offset by the harmful effects on the engine. Most of these fuel energizers use camphor as a basic material. If these dopes are used for any length of time the camphor will badly gum up the piston rings and cylinders and may even cause the pistons to stick.

The best gasoline saver is the hot spot device on the manifold. This arrangement takes on a number of different forms, but they all make use of the exhaust gases to better vaporize the fuel. During the cool weather of this spring I have increased my gasoline mileage as high as 25 per cent, to say nothing of the remarkably improved engine performnace. A device of this character is absolutely necessary with present grades of fuel, all of the new cars being so equipped in some manner.

The claims made for many of the so called gasoline savers are based on tests that do not represent the most general running conditions and therefore are apt to be misleading. The fact that some devices prove absolutely worthless does not necessarily condemn them all, but the great difficulty is in determining those with merit. Here, as in other cases, experience is the best and only teacher.

N. A. S., Cumberland, Md.

Steam-Cleaning the Gasoline

Everyone who drives on a cool evening at dewfall has noticed an increase in the power of his engine. It is apparent from this phenomenon that if the air is slightly moist it will assist in producing a better mixture. That the introduction of some moisture

into the intake pipe will produce a similar effect is evidenced by the increase of power that usually accompanies the use of a vaporizing device.

Carburetion, or the mixing of air and fuel, is a big problem today and is attracting the attention of every automobile engineer. The point at which gasoline will vaporize is constantly going up the scale, or to state the fact more clearly, the quality of fuel is dropping steadily. As an actual fact, the lower test fuels, such as kerosene, contains more heat or power units, and should there be a carbureter designed that would enable one to utilize the power units of kerosene as fully as those of gasoline, the car mileage per gallon of fuel would increase greatly.

The writer's car is fitted with a Zenith carburetor with hot air attachment and is at present running on half gasoline and half kerosene, but the great difficulty at first in using the kerosene was its effect upon the spark plugs, in making them soot up badly and causing loss of power on hills. Going into these conditions thoroughly, the writer tried out several suggestions offered by friends, but finally constructed a device to remedy this trouble by fixing a water by-pass to run into the hot air attachment above the exhaust pipe (about 15 drops to the minute) which was flashed into steam and carried in with the hot air to the cylinders. The car with this attachment has been run all the past year, the engine being in perfect condition, the plugs not sooting up readily as this device seems to keep the carbon thus formed quite soft.

It is noticeable that a number of cars hereabouts are fitted with a device which combines a gas economizer, a super heater, an electric super heater, a primer and a decarbonizer, all in one, and from their owners' experiences are, in every instance, giving excellent and constant service. This device primes raw gasoline up to the electric or super heater which transforms the gasoline into gas, delivering it into the manifold pipe, thoroughly mixing with the incoming charge, causing the engine to start instantly under any temperature.

With the low grade gasolne now being used, difficulty in starting is not the only drawback; there is always the chance of a certain proportion of the gasoline not being translated into useful work under normal running conditions, and therefore being wasted. All unburnt portions of the gasoline have a deleterious effect on the properties of the lubricating oil, with which they mix, and also tend to cause rapid carbonization of the pistons and combustion chamber and to foul the spark plugs. To overcome these conditions, the gasoline must be vaporized and burned. Experience shows that the application of heat to the carburetion system is the most practical means in assisting to this end. Such heat is usually derived from the exhaust gases,

or the water circulation system, or by means of air heated in passing through a chamber surrounding the exhaust pipe.

Practically every carbureter has some form of adjustment which modifies the quality of the slow running mixture. This adjustment is provided mainly because of the different air temperature at various seasons, but also because the total of air and compressions leakage in an engine varies considerably. Metal surfaces wear and washers rot. Consequently, this quality adjustment deserves complete comprehension by every car operator and amply repays time spent in adjustment. How many readers of MoToR have touched this adjustment and how many know where it is and what it is like on their carbureters. The writer finds it pays to reset his every three months on an average. Neglect of every car operator to do this is responsible for many of the starting troubles which they ascribe to bad gasoline and cool weather.

J. Gilman Frederick, Edgewood, R. I.

TROUBLE IN THE FUEL SYSTEM

THERE are three systems of fuel feed on the present-day cars; these consist of first, the vacuum system, the gravity system and the pressure system. The vacuum system, although the newest system of the three, predominates to-day, followed by the gravity and, lastly the pressure system.

There are several troubles which may be encountered in all three systems, mainly a stoppage of the fuel, due to the presence of water, causing irregular firing and in some instances failure of the motor. These faults may be remedied and avoided by draining the line and tank occasionally at their lowest point and blowing out the line with compressed air or a good foot pump.

The vacuum system is now used on the majority of cars. This system seldom gives much trouble, but its occasional failure will puzzle the motorist who is not familar with its parts and their functions.

The system consists of three main parts. They are the outer chamber, the inner or vacuum chamber and the head to which the valves and float are attached. The outer chamber is simply a container and will give no trouble, except perhaps an occasional leak, which may be easily soldered. The inner chamber has only one part which could give trouble, which is the flapper valve; if the system is taken apart for any cause, this should be examined for a good seat; if the same is not tight it may be remedied by rub-

bing the valve back and forth on a fine mill file, rotating at the same time. The seat should be given like treatment until a perfect seat results. The head with valves and float is, perhaps, the most complicated part and more likely to give trouble. This may be caused by a logged float, broken springs, or bad valves and seats. A logged float may cause too high a level to be maintained, causing gasoline to be drawn directly into the motor, causing irregular firing or its failure altogether. This may be remedied by placing the float in hot water, when the leak may be located by bubbles issuing from same. This leak should then be enlarged and another hole punched directly opposite to allow the fuel to run out. When this has drained entirely from the float the holes should be soldered, using as small an amount of solder as possible to prevent increasing the weight of the float.

The two cold springs may be tested by moving the float up and down and noting if the valves are tripped quickly and securely. If their action is delayed or weak, new ones should be substituted. The valves should all be tested for a good seat by closing same, sucking the air from the outlets and placing the tongue over the openings. If the air enters around the valves they may be seated by grinding in with a little pumice stone and water. When putting the system together examine the gaskets and renew same if torn or in bad condition. The vacuum line must be airtight and the fine gauze cleaned of sediment when the system will operate successfully.

The gravity system offers no complications and will give no trouble, except an occasional cleaning of the line and container, as with the vacuum system this tank or container must have a free vent in the top to allow the air to enter as the fuel is used.

The pressure system seems to be gradually losing favor. This system consists of an air-tight fuel container and some attachment to supply air pressure to the same. This must be supplied to the tank by a small pump when the motor is idle. The air line and valves must be in good condition or there will seldom be sufficient pressure for the morning start. The operation of the pressure system may be checked by the dash air gauge, and its failure may be due to leaky air lines, leaky tank or filler cap, and air pump failure. The remedy for all but the latter is obvious; if the pump is at fault it must be removed and tested for bad valves, broken spring, worn plunger or barrel. A. W. Hubbell, Lockwood, Mo.

Dirt Is the One Great Enemy

Cleanliness and common sense are the only things needed to keep the vacuum fuel feed system in perfect order. I allude to the system which I have had on three cars and which, barring one trouble of which I will tell later, has not caused a moment's difficulty.

There are just three points about which to be careful in the use of this system:

1. Open the pet-cock at the bottom of the vacuum tank once a week and drain a few tablespoonfuls of liquid from the tank. The liquid thus drained will be found to contain some water and more or less dirt in addition to gasoline. At times, it may be necessary to run a wire into the pet-cock opening in order to clear it. This happens only if very dirty gasoline has been used, or if the weekly draining has been neglected. There is a stand-pipe at the bottom of the tank that allows the dirt and water to accumulate, but if they rise above the level of this pipe they will be carried over to the carbureter and trouble will ensue.

2. Clean the little strainer at the top of the tank, where the gasoline supply enters, at least once a month. Also, if the carbureter has a strainer (most of them have nowadays), clean this too. Remove them both, shake them up in a glass partly filled with gasoline and see that the fine meshes are clear of dirt and lint before replacing them. A dirty strainer on the tank will cause it to get gasoline too slowly. A dirty strainer on the carbureter will starve it—and, while the car will apparently be all right at moderate speed or with a light load, it will be loggy and lack power on a long pull or when speeded up. Dirty strainers are often responsible for many baffling difficulties.

3. Don't let your main gasoline tank get empty. In the course of a few thousand miles a good deal of dirt and water accumulates at the bottom of a tank, unless you strain every drop of your gas through chamois—which few drivers do. When your tank runs low, this stuff, which is at the bottom, is drawn into the fuel line, vacuum tank and carbureter, and the only remedy, in most cases, is the complete dismantling and draining of the fuel system. Use a little forethought. Look at your gauge before you start anywhere and keep your tank at least one-quarter full all the time.

The one troublesome experience that I had with the vacuum tank was on account of a leaky float. When the float leaks it fills with gasoline and becomes too heavy to let it rise and

close the valve that shuts off the suction from the intake manifold. The gasoline is then drawn into the intake, and in addition to the normal supply from the carbureter, it makes a very rich mixture. The engine chokes, spits, runs on one or two cylinders only, you have muffler explosions, black smoke and all the other evidences of an over-rich mixture. Naturally, your first impulse is to change your carbureter adjustment—but don't do it. Disconnect the pipe that leads to the intake manifold and hold your thumb over the end of the pipe to shut off the suction. Then, if the engine runs normally, you know that the float is wrong and the carbureter is right, because what you have done has simply converted your fuel feed system into a gravity feed.

Now for the remedy: Re-connect the suction pipe and remove the little plug in the top of the tank. In some motors this will leave the motor with enough suction to draw gasoline into the vacuum tank, but not enough to permit it to be sucked into the manifold. If this doesn't work, refill the vacuum tank through the opening left by the removal of the plug (I always carry a clean oil gun and a length of rubber hose for this and similar emergencies). Then run as far as your tank-full will carry you, repeat the process, and make your way to the nearest garage or service station. It is an easy matter to repair a leaky float at home, but I don't recommend it as a pastime on the road. In any event, don't try to run home with pure gasoline being pumped into your cylinders, unless you are prepared to pay for cylinder regrinding, new piston and rings, and possibly a new set of bearings —all of these being among the pleasant possibilities of "taking a chance."

There are other things that may go wrong with a tank, but they are of rare occurrence. The flapper valve (the valve between the upper and lower chambers) may go out of commission as a result of being held off of its seat by a bit of dirt. Nine times out of ten a smart tap on the side of the tank will dislodge the dirt. If the various connections are allowed to work loose, all sorts of mysterious troubles will appear. But dirt is the great enemy—and, as I said at the beginning of this article, if cleanliness and common sense are used the vacuum feed system will prove itself a faithful, dependable servant to the motorist.

W. S. HAMBURGER, Baltimore, Md.

A Little Care, A Little Attention

The shellacked cork float, when this is used in the carbureter, will invariably, after three or four years' use, become loaded or saturated with gasoline, causing the gasoline in the chamber to rise above the normal height or flood.

The remedy is to replace the float with a new one, if obtainable, or repair the damaged float by first removing it and immersing in alcohol for three hours or more. This softens the shellac, and with a clean rag the cork should be wiped clean. The quickest way to dry out the cork is to place it on a radiator or on some warm, but not hot place.

Two coats of shellac should be put on the cork, by immersing it in a thinned solution of shellac and alcohol, with two hours between the coats. After allowing the last coat to set for about five hours, the float is ready to be replaced.

The float needle valve and seat, after use, become roughened. This allows the fuel to flood the float chamber and dribble down. A particle of grit or dirt lodged on the seat will cause the same difficulty. Flushing the carbureter will dislodge the dirt usually, but if dripping persists after this treatment the needle point should be ground in on its seat.

Use a paste of flour of emery and oil to restore the roughened surface to a smooth seat and finish the grinding with a little powdered pumice stone and oil.

Before replacing the carbureter on the manifold, a simple method of testing float and needle valve repairs is with a glass bottle and a rubber tube.

Fill the bottle partly full of gasoline and connect it up to the inlet union of the float chamber.

Raising the bottle above the chamber permits the fluid to run into the carbureter, when you can watch the action of the float and valve. To make further adjustments, the needle valve is depressed and the gasoline runs back into the bottle.

The float in the vacuum fuel feed tank when one is used is usually a hollow metallic float. If this develops a leak, the feed supply is diminished or stopped altogether, depending upon the amount of gasoline which enters the float. Shaking the part when removed will readily indicate whether or not a hole in the metal exists. When such a condition is found, the hole should be enlarged with the point of a pin, the gasoline drained out and the opening closed with a drop of solder.

The gasoline piping sometimes becomes clogged and this is caused more often than otherwise by sharp bends in the pipe. The restricted area at these points will gradually

fill up with foreign particles. This condition does not always cut off the supply of fuel, but diminishes it to an extent that causes irregular running of the engine.

When gasoline piping is found in contact with frame members or body parts of the car, it is a wise precaution to protect it by a piece of rubber pipe slipped over the tubing, or by wrapping it well with tire tape. As the gasoline tubing is of thin material, the chafing at these points of contact will quickly wear a hole through it. A compression type of coupling, the size of the fuel pipe, is a good investment, and with one of these in the tool equipment, it is possible to make a permanent repair on the fuel line at any place.

Tank leaks are commonly the cause of most difficulty with the main fuel reservoir, and the remedy is to remove the tank and solder.

Small holes in a tank can be repaired without the removal of the tank by using brass puncture plugs sold for use on bicycle tires, or with a small bolt and nut and one or two faucet washers.

To place these in the hole in the tank, a wire is run through the hole and out of the filler cap opening. Securing the screw bolt or the threaded end of the puncture plug to the end of the wire, it can then be brought to the opening and the head screwed on, making a dependable and easily accomplished repair.

G. A. Luers, Washington, D. C.

CHAPTER IV

THE STARTING AND LIGHTING SYSTEM

STARTING AND LIGHTING TROUBLES

IN order to have one's starting and lighting system operating at its highest efficiency it will be necessary for motorists to know something about their electrical equipment. It is true that electricity never fails if it is given the mechanical assistance necessary for it to do its work. When breakdowns do occur it is not because some unseen energy has failed to perform as it should, but simply because the mechanical conditions necessary for efficient operation have not been maintained.

The maintenance of an electrical starting and lighting system for a motor car amounts to keeping the attention focused on keeping the mechanical side of the apparatus in good order. There are three electrical circuits on an automobile; these namely, are the starting, lighting and ignition.

Short circuits in the starting system can be located at the battery by removing the negative wire from the battery and putting one of the test lamp terminals in contact with the negative pole of the battery, and the other terminal in contact with the end of the detached negative wire. When a short circuit is found the lamp will generally light, unless some special conditions are present.

Perhaps there is a short circuit in the entire starting motor caused by a ground between the starter and a second ground between the starter and starting switch. Where these conditions hold, the test lamp will not light unless the switch is closed. In locating trouble in the starting system observe carefully that none of the parts are fused or burned away, and also that connections are solid. Often it is difficult to locate a grounded or short-circuited starting switch, due to the insulation hiding the break.

The ills of the starting motor are few and if any are present they are of a mechanical nature. On both the starting motor and lighting generator, dirty commutators and

minor troubles in the brushes and their holders are the chief troubles. Considering the commutator, if the segments are found to be blackened or rough due to the use of short or worn brushes or cheap ones with poor electrical qualities, and poor contact as the result of too weak spring pressure. Commutators should present a bright coppery appearance and when covered with carbon dust should be cleaned. Brushes should make good firm contact with the commutator which they should fit exactly. Trouble caused by sticking brushes due to dirt or grease may be cured with a few drops of gasoline.

Weak spring pressure may be remedied by pulling out the spring with the hands. Light sand paper, not emery should be used on the commutator to clean off the black accumulation. Though the amateur should not go too far in making repairs upon the generator or other complicated electrical apparatus.

There are two main parts to the lighting system. The first is the battery, lamps and switch buttons and connecting wires, and second is the generator, battery and the cut-out relay system, together with fuse connections and regulator. To find troubles in this system it is only necessary to carefully go over the system step by step with the use of a wiring diagram of the particular car where one is locating trouble. These diagrams can be found in the instruction book. The part of the lighting system consisting of the generator and regulator should not be repaired by others than experts. The makers responsibility ceases if one breaks the generator seal.

The ammeter is useful in finding trouble in the lighting system; should the current be indicated when the switches are off, it suggests a short or ground. However, in testing the battery it is neccessary to find if the troubles are distributed throughout the entire battery, or confined to one or more cells. This can be readily determined by placing a small voltmeter across each cell to show whether it is giving the two volts required. One of the first places to look for trouble is in the electrolite solution within the battery. Keep this up to the proper level by the addition at regular intervals of distilled water or melted artificial ice so that the plates are kept covered. This is put in once a week in summer and every two weeks in cold weather. The next point to be considered is the specific gravity of the electrolite. Unscrew the caps and with use of a hydrometer take the reading of each cell and compare each reading so you can

tell if each one is in good order. In every case the solution is returned to the cell that it is taken from. Of course, all readings should be taken before the addition of distilled water.

In a fully charged battery the reading would be between 1,275 and 1,300. Never allow this to fall below 1,150. So much for ordinary care; more serious attentions should be left to the service station.

1. The most common troubles are these: Battery discharge may be due to improper charging; or short circuit in the lamp system, in the battery, circuit breaking or regulating mechanism, or generator.

2. Lamp shorts, bare wires touching each other, due to poor taping. Loose strands, bridging terminals, or defective sockets.

3. Battery shorts, worn-out battery, excessive sediment in the bottom, acid on top of battery, sulphated terminals acid soaked wire. Acid may be wiped up with waste soaked in ammonia.

4. Lamps won't operate or dim with engine stopped; lamp shorts, switch shorts, battery shorts, wire shorts, circuit-breaker shorts or open circuits.

5. Lights out with engine running, defective generator, weak field magnets, burned out armature, commutator trouble, faulty brushes, defective circuit-breaker or open circuits.

6. Some lamps bright and others dim, due to local trouble; partly discharged battery, defective circuit breaker, broken lamp filament, partial shorts, bad switch, connector or lamp socket, grounded wire, improper lamp voltage, defective or burned out lamp.

7. Starting motor cranks too slowly; battery in bad condition, also wires, poor brush contact, commutator troubles, mechanical disarrangement of starter engaging system. A little oil in the right place at the right time goes a long way towards prevention of trouble, especially in the generator. R. L. Prindle, N. Abington, Mass.

Locating and Eliminating Troubles

While starting and lighting systems have been developed to a high state of reliability, yet this is still the weakest unit of an automobile and is subject to frequent derangement. The electrical equipment seems complicated to many, but only a fair knowledge of the system and a small equipment are required to repair practically all troubles.

The commutator and brushes seem to be the most vulnerable parts. Trouble in this element usually manifests itself by a slow current output in the generator, or sluggish operation or refusal to start in the starting motor. By removing the name plate on each machine the brushes and commutator are exposed for examination. If the commutator is blackened and rough the brushes have not been seating properly, causing them to arc and foul the commutator. To restore this element to good condition requires that the brushes and commutator be sanded in.

The best method I have found for this operation is to cut a piece of 00 sand paper slightly wider than the brush and place it around the commutator for half of its circumference, smooth face down. By drawing the sand paper back and forth the brushes are cleaned and trued up to fit the commutator. To sand in the commutator, the motor or generator should be run at low speed and a piece of the same grade of sand paper held over half of the circumference of the commutator until it takes on a bright polish.

The best indication for a need for sanding in is a squeaking noise in the commutator, while one having a fine polish, with a bluish purple tinge, is in the best of condition. On the other hand, a commutator with a dark rusty color will usually show that the mica separating the commutator bars is flush with or higher than the commutator, causing the brushing to arc and in time burn away the copper. This condition materially reduces the efficiency of the machine and is responsible for many troubles. The car should be taken to an expert repairman to have the mica under-cut.

An insufficiently charged, or discharged battery can often be traced to the regulator or cut-out. To check the closing of the circuit a voltmeter should be connected across the terminals of the cut-off; the contact points usually close at a voltage of from 6½ to 7½ volts on a six volt system, and from 13 to 15 volts on a twelve volt system. The contact points should be open when the discharge current from the battery to generator is approximately zero. An ammeter placed in circuit with the current coil will indicate the amperes discharge at the breaking point. Should the cutting-in voltage be too high the air gap between the points should be reduced, and when properly adjusted is about 1/32 inch. Reducing the air gap usually has the effect of increasing the rate of current discharge on cutting-out, but this will be overcome by increasing the spring tension very slightly. The contact points should be kept clean and trued up with

emery paper to touch evenly all over their surfaces. While there are necessary differences in the cut-out of various systems, the method used above is typical and adapted to most electric systems with but few changes.

In common with others, I have often experienced trouble in the wiring of both starting and lighting systems. When the wiring is suspected, and the switches and terminals are O. K., the application of the few simple tests given below will readily show where the trouble is located.

Short circuits caused by grounds can be tested for by running the generator, with all lights turned on and horn and starting circuits open. A piece of wire several feet long is held in contact with the positive terminal of the battery and with the other end touching the frame of the car. Should a spark result there is a ground on the negative side of the wiring. The reverse application of this test will indicate a short on the positive side of the wiring. Obviously this test applies to any two wire system, since there is an intentional ground on the single wire system.

Another method is to rig up a lamp tester, consisting of an ordinary base and six volt bulb, connected with two short lengths of wire. Pieces of steel, with fine needle points for piercing insulation, are soldered to both wires. With this outfit it is readily possible to isolate the trouble to one particular section of the wiring, and that unit of the wiring last disconnected before evidence of the trouble is shown by lighting of the bulb, embraces the defect.

When lighting troubles are not due to the wiring, bad bulbs, loose terminals or defective switches, the contacts of the sockets may have become corroded or the spring too weak to maintain good contact. It is advisable to replace such a socket, as time and trouble will be saved by its installation.

Fuses have given more or less trouble, particularly when some failure in other parts of the system should throw an excessive current load on the lighting system. A blown fuse is easily tested for by placing a screwdriver across the terminals. If the bulb lights the fuse is defective and must be replaced; if the bulb refuses to light look elsewhere.

To those mechanically inclined and possessing a fair knowledge of the rudiments of modern electric systems, the correction of troubles in this element should not prove edifficult.

N. A. S., Cumberland, Md.

Just Give It a Fair Chance

The starting and lighting system of our present day cars is highly developed and is practically free from inherent defects. Trouble is directly attributable in the majority of cases to carelessness or lack of information of the functions of the various parts of the system.

The storage battery is the weakest point of the system in that it requires the most attention, but even it, if given half a chance, will do all that can be reasonably expected of it.

Two of my friends in the early fall were discussing the advisability of attaching some form of priming device to insure easy starting. One had decided to use a certain well advertised primer, while the other concluded he would not as his motor was "always" right.

When their cars were put up for the balance of the winter the batteries were removed and I had an opportunity to observe that the battery of the fellow who did not use a primer indicated advanced sulphation while the other battery was in excellent condition.

The cause of this state of affairs was plain. A motor with the oil on all lubricated parts congealed requires a great deal more power to turn it over and the low quality of the mixture from a cold carburetor calls for a greater amount of spinning which two conditions overtx the battery.

A good priming device, and there are several on the market, by insuring a rich starting mixture, would call for a minimum amount of motor spinning and thus greatly lessen the drain on the battery.

Then also the lights are used to a much greater extent in the winter, thus depriving the battery of much needed charging current.

Often opportunities present themselves, especially in city driving to run with dimmed lights and this expedient for saving current should be resorted to in the winter months.

Probably the greatest source of battery trouble and short life results from not keeping the plates covered by the addition of pure distilled water. The addition of water should be made about once a fortnight during the open season, but it is so easy to overlook the matter that I have mounted a small piece of unglazed white celluloid on the dash with the months printed thereon in a vertical column and opposite these I mark the day of the month on which I inspect the battery.

This matter of adding water is so important that some car manufacturers place a warning on the dash or floor boards.

J. F. C., Meriden, Conn.

Follow the Instruction Book and Be Safe

While I have had a few troubles with the lighting and starting systems of my car I am willing to confess that it is my own fault and cannot be laid to the manufacturer of the different units. The troubles as I have found them through my friends and my own experiences are summarized as follows:

Battery: Not fastened securely; neglected; overworked.

Wires: Loose connections; worn insulation; broken terminals.

Generator: Worn carbon brush; commutator needs cleaning; cleaned and free from carbon, dust and loose metal particles.

A loose battery sliding back and forth in its receptacle will in time cause worn insulation of wires and short circuits. Distilled water kept at proper level above plates in battery and specific gravity of the electrolyte taken with a hydrometer every week in the summer and every two weeks in winter will save trouble and annoyance. To be on the safe side have the battery examined and tested by battery expert or service station once a month. If the battery is run more in the night than day it will necessitate having the charging from an outside source occasionally as the generator will be unable to keep the battery charged fully enough to turn engine over.

Next trouble can be found by not having terminals of wires fastened securely. Worn insulation of wires when touching metal will cause a short circuit. To remedy this requires new wire or covering of worn parts with tape.

The generator should be inspected every 2,000 or 2,500 miles and the commutator cleaned with fine sand paper while generator is running. Clean out what dirt and carbon you find and make sure that the insulation of commutator is free from all metal particles.

Replace old carbon brushes with new ones.

To make sure of less trouble a good policy to follow is to carry extra bulbs for lighting system and extra carbon brushes in tool box. While I have given a few troubles and remedies I feel that should the car owner follow the instruc-

tion book that comes with every new car that he would not experience any great amount of difficulty.

C. A. Du Bois, Waltham, Mass.

THE CARE OF THE LIGHTING SYSTEM

THE most likely source of trouble in a present-day automobile electric lighting system are short circuits and open circuits. With properly designed and constructed systems trouble from faulty batteries and generators should be relatively rare.

Short Circuits—In cars where the single wire system is used there will be a short circuit wherever any portion of the wiring comes directly in contact with any metallic portion of the car. The same will happen with double wire system only when both sides of a circuit become grounded in this manner. Such complete short circuits will completely discharge the battery in a very short time and may cause irreparable damage to it. All lights will go out in the event of short circuits and the ammeter needle will indicate the extreme end of its discharge scale, unless the trouble is between this instrument and the battery. Lighting circuits should be provided with fuses, which by blowing out, may prevent exhausting the battery. When this is the case, the only caution needed is that after the inoperative circuit has been located by trying the different switches, the cause of the trouble should be removed before inserting the new fuse When circuits are not protected by fuses, the battery must be disconnected by some means as quickly as possible and the whole wiring system examined.

Leaks or small short circuits which discharge the battery but slowly, may be detected by the inability of the battery to hold its charge. The needle of the dash ammeter will also indicate leaks when the lamps are not in use, unless they be between the meter and the battery. In this event, disconnect one of the battery terminals and connect between the cable and its binding post with a packet meter. If no current is being used at all the meter will indicate zero. Short circuits are not indicated by the dash ammeter when the lights are off, unless they be between the meter and the switches or in the switches themselves.

There remain "shorts" on the lighting circuits. These should be switched on separately and the amount of current normally consumed noted on the ammeter. This will usually be found to be about 1-5 amps. per candlepower. Should the consumption of any circuit very much exceed this, the circuit should be examined for leaks.

When the trouble has been narrowed down to a single cir-

cuit, the cause of leakage will most commonly be found among the following: The wearing away of insulation which is in contact with metallic parts. The cutting through of insulation by metal holding slips. The soaking through of insulation by lubricating oil filled with metallic particles. Faulty or frayed cable ends at sockets, switches, connectors, especially where two terminals of opposite polarity are close together and two strands may unravel and bridge across.

Open Circuits—The going out of all lamps of one circuit, of course, indicates trouble in that circuit only, while the extinguishing of all lamps indicates that the breakage is common to all circuits. The most common causes of open circuits are loose contacts at binding screws, switches, connections at lamp sockets, besides the shaking loose of lamp bulbs. When the trouble has been singled down to one circuit, the writer prefers the bridging method of locating the trouble, taking each connection and length of cable in succession and bridging around it temporarily with a piece of wire. Leave the switch of the circuit on and when the lamps light the wire will be bridging the break. Thus by elimination the trouble may be expeditiously located. The most fruitful causes seem to be located at the switches, due either to loose contacts or faulty switches.

"Push in" connectors which depend on friction for their contact may wear sufficiently to need a slight bending. The springs of Edison type connectors may lose their strength and thus require renewing. If both lamps of a circuit burn intermittently, the loose connection is probably at the switch, but if only one lamp is affected, the trouble is in the lamp socket or connector. If one lamp of a circuit goes out, exchange bulbs. If the new bulb fails to light, the trouble is in the wiring; otherwise it is with the bulb.

The electric lighting system is a delicate piece of mechanism and as such it behooves the motor car owner to give it constant and consistent care. J. T. L., Worcester, Mass.

Testing the Storage Battery

Being the weakest part of any electric lighting and starting system, the storage battery is apt to prove the source of the trouble in the majority of instances. Not that there should be any particular trouble with a well-designed electrical system, properly installed, and properly looked after, but when it does occur that is the most likely place to look for it. Next in the order of their vulnerability are the contacts, *i. e.,* the switches and other movable contacts that are in constant use; after these, the commutator, or commutators, according to

whether the system is a single or double unit type. Last, but not least, there is the wiring. If installed according to modern standards which call for armored cables, trouble with the wiring should be rare indeed, barring accidents which permit some moving part of the car's mechanism to come in contact with it and damage it. There is still another contingency, but this is so rare as to be practically negligible, particularly as the remedy is something that would be entirely beyond the driver's ability to repair anyway. This is failure of the generator or motor to operate, due to damage to the armature windings, or possibly, to its internal connections, such as field leads, etc.

Now for the system of examination. Lights do not burn brightly. If they have been replaced recently examine to see that bulbs of proper voltage have been obtained. If this is O. K., inspect battery. See that acid spray from vents has not been allowed to accumulate on lead straps and top of cell so as to partially short-circuit them. Use hydrometer and note whether battery tests 1,275 when fully charged. Add distilled or rain water to bring electrolyte (solution) to this point and to cover tops of plates. Give top and straps a good cleaning and if acid spray has caused any corrosion pour an ounce or so of melted paraffin on lead straps after cleaning, so that it completely protects the metal. Heavy grease will serve the same purpose. See that all connections are clean and tight. The foregoing also constitutes the procedure to be followed when starting motor is apparently receiving insufficient current, as the cause is apt to be the same.

If the trouble persists, examine movable contacts and, if dirty, clean with very fine emery cloth, wiping them off subsequently with an oil-dampened cloth. Should this remedy not prove effective and the ammeter indicates that the battery is not receiving its usual charge with the motor running at its usual speed, examine the brushes of both the generator and of the starter (if two-unit). Use the emery cloth, applying lightly while running, and wipe off as directed. See that all connections at brushes are clean and tight. This applies to other parts of the system, as well as the brushes. This failing to remedy the trouble, a partial break, ground or short circuit in the wiring system may be suspected, but it will rarely be necessary to go that far. The battery, switches or brushes will be found to represent the seat of the defection in the great majority of instances, and in about the order given. To reduce such troubles to a minimum the battery ought to be given the inspection and care described once every two or three weeks, while the brushes and contacts should be cleaned about every three months. CHARLES B. HAYWARD, New York.

THE LIGHT THAT WILL NOT FAIL

IN some lamps the range of adjustment, that is the movement of the bulb in the reflector, is so limited that a suitable light can be obtained only with a certain size and type of bulb. The owner of a car fitted with such lamps, not knowing this defect, may purchase bulbs merely by voltage, when, as a matter of fact, he should get a lamp of that voltage and of a certain definite type of filament. It is, therefore, essential for the motor car owner to use the same type of bulb in his lamps all the time, and in order to make sure of being able to do this, he should always carry a few spare bulbs with him on the car, in a special carrying case, designed to prevent injury or breakage of these fragile spares. Very often it is impossible while on the road, to purchase bulbs of any kind and still more frequently it is impossible to get the exact type and size of bulb that gives the best results with the particular lamp in service. All bulbs have not the same size globe the filament is not always of the same length, nor of the same shape, hence it is vitally important to find just the bulb that yields the best results with the lamp used and have a supply of that bulb always in the car ready for immediate use.

In buying a new bulb the size of the electrical contacts on the base should be inspected for the reason that many bulbs have too much solder on the contacts. The contact pin will jam against this lump of solder and in many cases prevent the proper anchoring of the bulb in the socket. This can be remedied by scraping the excess solder from the contacts with a penknife, or it may be filed off without any difficulty.

Carrying cases for spare bulbs are to be obtained in almost any supply store and they are most useful accessories in the car. Many communities have rigid laws for the arrest of car owners whose vehicles have a license pad not plainly visible at night for a certain distance. This is not a universal law, but one can never tell when he may be in a town where it is being enforced.

In order to get the best road illumination out of the headlights they must be properly focused. Some owners do not know that lamps must be focused, while others have worked hard to get the proper focus and have finally given up in disgust. That may not have been their fault, for, as we mentioned before, some bulbs in some lamps absolutely prevent proper focusing. In focusing headlights to obtain the desired road illumination, proceed as follows: Drive the car to within twenty feet of the side of a barn, screen or other flat perpendicular surface. Notice the image of the lamps. Adjust the focusing device so that the bulb will be as far in the rear of the reflector as possible. This should produce an image with a black spot in the center. If the black spot does not appear it proves that the socket adjusting device is

limited in its rear movement. If the black spot is not concentric with the image and appears off to one side, or if the spot is not circular, it proves that the filament is not in the axis of the reflector.

Place the rubber end of a pencil on the tip of a bulb and move it in all directions noting the effect on this black spot. If by moving the bulb in a certain direction the black spot is made to be concentric with the image it shows that the socket does not hold the bulb in proper position. This can sometimes be remedied by removing the bulb from the socket, giving it a half complete turn before placing it back in the socket.

If, on the other hand, the bulb has a tendency to spring away from the proper position it is the fault of the socket, or focusing device, and can only be remedied by a lamp repairman.

In order to eliminate this black spot adjust the bulb by moving it forward until you obtain the desired image. In some socket adjusting devices the movement toward the reflector is not as great as the movement away from the reflector, therefore the above images may be obtained by moving the bulb out of the reflector as far as possible.

There are many different varieties of adjusting devices in modern headlamps, some of them operated by turning the bulb, others by turning a screw at the back or perhaps on the rim of the lamp. The mere turning of the adjusting device is not all, for some of the devices are defective so that when it is thought a focus is obtained the bulb is actually out of focus. In one bulb-adjusting type of lamp, the adjusting device, if sufficiently stiff to retain its position has a tendency to loosen the bulb from its base during the adjustment. This is true particularly of those devices in which the adjustment is obtained by rotating the bulb. In a lamp of this sort, care should be taken when adjusting that the bulb is not broken. In turning the bulb, if it is not done carefully, it is likely that it may be loosened from its base. In another form of lamp there is a spring behind the door which must be removed to focus. The bulb is focused and when the rim is installed it displaces the reflector slightly, throwing the lamp out of aim. The owner must in this case compensate for movement of the reflector or reaim the lamp after the door has been replaced.

There is still another form of defect which relates to lost motion in the device itself, or between the socket and the bulb base. This play permits a displacement of the light source, that is the center line of the filament does not coincide with the center line of the reflector. This gives a distorted image from the lamps and very poor light. Not all lamps have adjustments, which permit of this trouble evidencing itself. There is, however, another cause of this trouble which the owner may remedy. Some bulbs are

made with the filament center line offset from the bulb base center line, looking at the bulb you can see that the filament is slightly off to one side. The use of a bulb of this kind may cause trouble. It sometimes is possible when the filament is just slightly out of center line to remove the effect by changing the bulb position, but usually the effect is only slightly better. In Ford cars this is a common trouble sometimes caused by vibration, excessive voltage, or both. The trouble may come up in any make of lamp; however, the owner should accasionally examine the bulbs to see that the filaments are not drooping or otherwise thrown off center. Also when purchasing bulbs an examination should be made for filaments which are not exactly in line with the center line of the bulb.

Now the illumination may be right but the direction may be wrong. If the lamps are adjustable this is easily corrected. If not, the brackets should be bent so that more light is thrown upon the road and none of it is higher than forty-two inches. A blacksmith can bend the brackets if the car owner is not able to perform the task himself. On some cars there are brackets that cannot be bent.

Direct light is the light which comes, without being reflected, directly from the filament. It illuminates the road, and the sides of the road rirectly in front of the car. That portion of the direct light which rises above the axis of the lamp is practically useless and in the case of momentary glare tends to prolong the effect. Painting a portion of the globe with an opaque paint so that the filament of the bulb in the lamp cannot be seen above the axis of the lamp will eliminate useless direct light. In the case of the spotlight all direct light should be eliminated by the painting method. This will eliminate the light thrown upon the hood and mud guards of the car. This method makes it impossble to see any but the reflected light and the diffused light of the reflector, the latter being too small an item to be considered.

GIVING THE BATTERY A CHANCE

A STORAGE battery requires comparatively little attention, but that which the manufacturer asks be given it must be given at the proper time. To attempt to eat five days' rations at one sitting to keep one alive five days is obviously a silly procedure, just as much as the taking of a whole bottle of medicine at once instead of a teaspoonful at stated intervals. Similarly the cells of a battery must be properly brought to level with distilled water, but the owner must not follow the practice of waiting until the level is very low, and then pouring a big dose into the cells. This is mentioned just to bring out the importance of examining the battery periodically and giving it the care and attention that it deserves at the right time.

With a clear understanding of the construction of a battery and the actions that go on within it at all times, the owner is not liable to fall into the error of adding acid to the cells, or allowing it to remain in an undercharged condition or of overcharging it.

All the owner, whose car is equipped with a generator, has to do to his battery is to keep the plates in the cells covered with distilled or rain water, test the battery weekly or every two weeks with a testing instrument called an hydrometer and keep the terminals clean. These, in a general way, are the things which must be done at least once each week in summer and once every two weeks in the colder weather. The time required to perform them should not be over ten minutes. The detail of the operations and other matters relating to batteries will be taken up presently.

The ordinary lead battery with which most of our cars are equipped is commonly but wrongly called a storage battery. The word storage gives the impression that electricity actually is stored in the battery much the same way as liquor is stored in a barrel, or furs in a chest. The lead storage battery is a chemical machine containing plates completely covered with a sulphuric acid solution of a specific gravity of 1.30 at 70 degrees F. There are two kinds of plates in a battery—positive and negative, called so because of the direction of current flow through them. Current from the battery always leaves by the positive end and this is called plus (-|-). The negative or return is the minus (—). The plates are in the form of grids made of a lead alloy and the spaces in the grids are filled with certain lead compounds. In the case of the positive plates lead peroxide, which has a reddish brown color, is used as the active material or grid filler and in the negative spongy lead is used. These are the main ingredients of the positive and negative plates.

When a number of similar plates are connected, the unit is called a group, and when a positive group and negative group are interjacent so that the positive and negative plates alternate, the unit is called an element. In an element the plates are prevented from touching one another by interposing separators between each two plates. These separators in most lead batteries are made of treated wood, although other special forms of separators are not uncommon. When one of these elements, or combination of positive and negative plates, is in place in a hard rubber jar almost filled with sulphuric acid solution, or electrolyte, the unit is spoken of as a cell. A battery is composed of cells one, two, three or more according to the battery capacity desired.

When a battery is being used, that is, when it is giving off electrical energy, that energy is the result of chemical action between

the solution or electrolyte and the plates. This chemical activity is going on all the time within the battery, but when the circuit is open, when the battery is not being used, the chemical action is reduced considerably. However, when the circuit is closed and the battery required to supply current, the action is much greater. The action is between the lead compounds in the grids and the solutions. This action results in the production of lead sulphate, a white compound which is deposited on the plates. In the production of this sulphate the electrolyte is robbed of some of its strength, and if the battery is left to discharge, the robbing continues until the plates are all covered with sulphate. When this condition exists pure water is theoretically left in the cells, and there is no further action. The cells are completely discharged and the chemical action, which caused the production of lead sulphate, has resulted in the battery giving off a certain amount of electrical energy. When the plates are only partially covered with lead sulphate, then the battery is partially charged, or it has a reduced capacity.

When an electric current is sent through the battery from some charging source, the lead sulphate on the plates is removed and the chemical action is the reverse of what it was on discharge. The chemical action on charge brings the battery to its former condition, that is, the solution becomes sulphuric acid and the active material of the plates are as before.

When a battery is charged or discharged heat is produced, and this heat causes evaporation of some of the water in the electrolyte. It is evaporation of the water of the electrolyte that is compensated for by the addition of distilled water to the cells. It is because only water is evaporated that only water should be added. The only time acid ever is added to the cells is when some of the solution has been spilled and this is rare. In this case the acid added should have a gravity of 1.30 and only a sufficient amount added to make up for that lost.

Every week at this time of the year the owner should remove the small caps which are found on top of the battery. These are called vent caps, and when removed make it possible to look into the cell and see the level of the solution. The liquid should entirely cover the plates as illustrated in one of the sectional views of a battery. If the level is low, add distilled water or rain water. You can buy distilled water at a drug shop and the rain water can be collected in a vessel. The water is best added to the cells after the solution has been tested with a hydrometer. This is an instrument for indicating the specific gravity of liquids, or in other words, it tells how much heavier the liquid is than water. Water is said to have a specific gravity of 1, sulphuric acid has a gravity of about 1.8, and mixtures of these have corresponding intermediate gravities. A cubic inch of battery elec-

trolyte. which has a gravity of 1.3 weighs 3 more than a cubic inch of pure water.

The hydrometer is a large glass tube with a bulb at one end and a piece of rubber tubing at the other. Inside this glass tube is a hollow glass cylinder weighted at the bottom. The cylinder is graduated. When heavy liquid is drawn into the large tube, by squeezing and releasing the bulb, the small graduated cylinder floats. When it comes to rest, the graduation on a level with the solution indicates the specific gravity of that solution. The gravity of any cell should be 1.28 to 1.30. If the gravity is less than 1.28, let us say, 1.15, the cell is discharged. If it shows 1.20, it is only half charged. This is easy to see, since the nearer the gravity approaches 1.3, the more nearly the battery is fully charged. If the gravity reading is 1.2, it is clear that the solution tested is only 2 heavier than pure water, but the solution must be 28 to .3 heavier when the battery is fully charged. A slight variation of say .1, between the gravity of the cells of a battery is permissible.

After the cells have been tested they should be brought to level with distilled water. Assuming, however, that one cell showed a much lower level than one of the others, it might be inferred that that cell has a leaky jar, or perhaps some of the solution has been spilled. Spilling of electrolyte calls for the addition of electrolyte of a gravity of 1.30. If the owner is not familiar with the operation of filling to compensate for spillage of electrolyte, it had best be done by the service station. In a general way a gravity of 1.30 will be obtained at 70 degrees F. by mixing twenty-five parts of water by volume with ten parts of sulphuric acid of a gravity of 1.83. In mixing, the acid should be added to the water and after the solution has cooled, it should be placed into the cell until the proper level is reached.

The addition of too much water may cause the excess to be forced out through the caps and this excess will corrode the battery case. Fill only to the level indicated which is slightly above the tops of the plates.

If after testing the cells for gravity it is found that the readings are below those specified, it naturally remains to charge the battery until the gravity of all cells is correct. The only way the gravity can be restored is by charging, and it is wrong to attempt to increase the gravity by the addition of any substance. If acid is added to bring up the gravity the separators and plates of the cell will be permanently injured, the active material will fall out of the grids, and little useful work will be had from that cell. It will be found in most cases of "high acid" that the active material is so soft that the least vibration causes it to fall to the bottom of the jar.

Quite often the owner finds that the solution level has dropped

considerably, and after filling with water the battery does not seem to "come up" on charge; that is, it does not appear to increase in gravity. This may be the result of a poor connection which does not allow the charging current to have the desired effect, or as is usually the case the battery has been idle in a discharged condition. Allowing a discharged battery to remain so for any length of time causes the deposit on the plates to become hard. This calls for a long charge at a low rate, and very often two or three chargings are necessary. In some cases the battery cannot be restored to normal condition. This shows the importance of adding water weekly to completely cover the plates and of making the necessary gravity tests of the cell solution. In a previous paragraph mention was made of the owner who complained that his battery did not produce current "even though it had not been used for four months." This owner allowed his battery to remain idle without any attention whatever, not knowing that the chemical action goes on all the time. His battery evidently was in a run-down condition and required careful charging to restore it to its former condition.

In automobiles the undercharging of batteries is quite common. Some owners will make a great many starts and stops, and each start draws a great deal of current from the battery. The car is not run sufficiently long after the start to replace the current removed in starting, with the result that the battery is slighly undercharged. Some professional men such as doctors may find difficulty in keeping the battery properly charged. A doctor may leave his car in the street for hours with the lamps burning and then a half hour later make four starts and stops. This procedure obviously draws more current from the battery than can be put back into it in the short time allowed for charging, resulting in an undercharged battery. However, by reducing the battery load and allowing the total generator output to be used in charging, it will soon bring the battery to normal condition.

One of the first indications of an undercharged battery, although this symptom may foretell another trouble, is weak cranking. The starting motor turns the engine over slowly. An undercharged battery may not have sufficient current left in it to supply the needs of the starting motor. The remedy, of course, is to charge the battery either by means of the generator on the car by allowing the motor to operate and not using a battery load, or from an outside source. The effect of an undercharged battery will be had if the owner neglects to fill the cells with water. In this state only a portion of each plate is submerged, and only that portion is acted upon chemically by the remaining solution. The result is that the battery output is low.

Undercharging may be the result of some derangement be-

tween the battery and the generator either in the connections, the generator, the current regulator, etc. An ammeter test at the generator terminals will soon tell whether or not the desired amperage is being delivered, and an inspection of the wiring from battery to generator will reveal any open or short circuits. All connections should be clean. The battery connections especially need attention, and after cleaning and drying them, a little vaseline will help materially in preventing corrosion with its harmful results.

Then there is an opposite condition which seems to be more prevalent now than undercharging, and that is overcharging. The only function of the charging current is to produce chemical action in the battery so as to restore the plates to their original condition by removing from them the sulphate deposited during discharge. If, after the plates have been restored the charging is continued, the current passing through the solution causes a breaking up of the water in it. This causes bubbling, and the heat produced has a bad effect on the plates, the tendency being to soften the active material and bend the grids. Also the overcharging causes gases to be formed in the plates themselves and in the effort of the gases to get out they push the active material out also. Those who drive their cars a great deal during the day start the engine only a few times and use practically no load because little, if any, night driving is done, may have overcharging troubles. Overheating and plate disintegration may be caused by neglect to fill the cells with water, but in either case the result is the same.

When it is known that a long run will be made, it is advisable to turn on the lamps to prevent overcharging. An inspection of the cells after a run of this kind will show whether or not the solution is bubbling too much. If the battery is overheated its temperature will be about 105 or 110 degrees, and at this temperature no further charging should be given. Allow the battery to cool first or require it to supply a load. In many instances the charging current of the generator may be regulated, and if a long run is to be made with no appreciable battery load, it is advisable to reduce the charging rate to meet the new conditions. Systems in which the charging rate is designed to overcharge instead of undercharge should be watched carefully.

In some districts in the North, owners find it almost impossible to get good battery service, because of the extreme cold weather which prevails during certain periods of the year. One fair way of lowering the freezing point of the battery is to keep the electrolyte at the proper gravity. The lower the gravity the higher the freezing point. With solution at 1.26, the battery will freeze at 60 degrees below zero, but at 1.16 or three-quarters discharged, the battery will freeze at zero, a temperature often

reached even in the more southerly states. In the extremely cold sections some owners make doubly sure by covering the battery with fur or cloth. However, if only the solution is properly watched little thought should be given to freezing.

Whenever trouble arises in the starting and lighting system, the first step is to examine the battery, not because it is expected to be the cause in most cases, but because the trouble may more easily be traced in this way. You know that if the battery cells all test 1.28 to 1.3 that the battery is in good condition, providing, of course, that this gravity has been obtained in the proper way and not by the addition of acid. With the battery in good condition you can confine your search for the trouble to the wiring, the regulator, the generator, etc. But, should the battery be at fault, should the cells not test up to normal, you can correct the trouble without difficulty by charging the battery. If it persistently becomes undercharged or overcharged have the lighting units examined, or analyze the case and determine if you are operating the battery under the wrong conditions, that is, giving the accumulator little chance to give the proper service.

Car storage during the winter months is done now by very few owners, but to those whose batteries will not be used for some time it is suggested that they be given the proper attention. There are two ways of storing a battery, and one is to give it to a garageman or service station with instructions to care for it and the other is dry storage. In the former the battery is given periodic charges and discharges, but in the latter a different procedure is followed.

In storing a battery under the latter scheme the battery is first fully charged after which it is dismantled and the separators removed, These separators are no longer fit for use. The plates are washed with water for about twenty minutes and then placed in a dry place to remain until again needed. Dry storage is economical and in one respect at least is better than wet storage. In dry storage there is no deterioration of the plates, which is the case in wet storage. As to cost it might be mentioned that for six months' storage a 6-80 battery will cost $4.50, a 6-100 $5 and 12-50 $6. When the owner receives the battery the plates will be in good condition, providing they were not injured before storage and new separators will be installed.

HEADLIGHT ATTACHMENTS

HAVING observed and experimented somewhat with methods of reducing headlight glare during the past season, I agree with certain illuminating engineers that absolutely satisfactory automobile illumination without objec-

tionable glare cannot be obtained with the use of the present type of parabolic reflector.

Methods of controlling headlight illumination may apparently be roughly divided into three classes:

1. A system having light controlled by suitable headlight lenses or screens so that light of high intensity is used only in the lower angles. Such equipment is satisfactory to the extent that when sufficiently powerful and controlled by sufficiently effective means, excellent road service illumination can be obtained without objectionable glare as long as the road surface is absolutely level and the controlling devices are not permitted to become displaced.

My experience with special headlight lenses is that they must be carefully installed in their frames and wedged with adhesive tape if necessary, to prevent any displacement. But obviously, road irregularity and curvature will cause elevation of high power beams in practice so that as far as passing travelers are concerned, the lights may as well not be controlled at all, whenever there is occasion to pass cars travelling in the opposite direction under such conditions. Also when approaching the foot of a hill, light will be concentrated on the foot of the ascent, thus limiting the range of illumination.

Lack of light in the upper angles is unsatisfactory since on country roads the absence of light on trees, fences, signs, and railroad crossings, and cross roads, makes it difficult to anticipate the direction of the road or to see a sufficient distance in advance to satisfy the requirements of safety. Increasing the upper beams will increase the glare for level roads.

2. A system by which light is diffused equally in all directions from the center of the headilght. The "bug" with this arrangement is that with most designs of lenses, objectionable glare is still present when the light is cut down even below the point of good average illumination.

3. A system whereby the degree of dimming quantity or light, or both, may be controlled by the driver.

Apparently it should be recognized that different driving conditions require varying degrees of headlight illumination and that the attempt to use one degree of illumination for all purposes can only be approximately satisfactory. A car standing by the roadside at night, needs only nominal illumination; for city driving, road illumination for only a short distance is required since there is usually plenty of general

street lighting and speeds are comparatively slow; for night country driving at considerable speed on vacant roads, a sufficiently powerful light is required so that changes of direction, crossings, obstructions, and other occupants of the road may be distinguished sufficiently in advance for the driver to govern his speed accordingly, and this degree of light should be cut down below the objectionable point when passing. On such occasions speed is so decreased that long range illumination is unessential.

The writer has found two sets of equipment to meet the above requirements in a fair degree.

One consists of powerful nitrogen filled bulbs used in conjunction with ground glass lenses having marginal star points and a variable dimming rheostat. At full power these lights are satisfactory for country driving, but it is necessary to use the rheostat a considerable portion of the time and to dim carefully when passing.

The other installation consists of twelve to fifteen candlepower bulbs and almost any form of dimming lenses which will obviate objectionable glare when passing without cutting down the general illumination unduly. These are satisfactory for driving on fairly well lighted streets and roads and need not be dimmed when passing. For country driving a good sized swivel spot light without dimmining lense must be employed, to be turned off when other occupants of the road come into view. This is of doubtful legality in several states.

The regulation of motor car illumination is a somewhat peculiar problem since the driver does not equip his car with non-glare devices primarily for his own comfort but for that of other travelers he meets, and to satisfy the law. Since, with the present means of illumination and light control, all regulation is a compromise, satisfactory illumination being impossible without some glare, there is a temptation to install equipment which will come just within the law, and depend upon the discretion of the driver for its proper use.

J. T. L., Montclair, N. J.

The Efficacy of "Ten and—"

Until the judge said "ten and" I never paid much attention to my headlights except to put in new bulbs when the old ones burned out. I used as large lamps as my battery would stand and had a fine path of light down the middle of the road. In town I used my dimmers when I thought of it, but

they didn't give me enough light to drive by where streets were not well lighted.

After meeting the judge I put some frosting on the inside of my headlight glasses and that let me "get by" the police all right, but I almost had to buy a new bumper because my lights would not shine far enough ahead to show me a wagon that was loafing along the road.

Bought a pair of lenses of the "scatter" type and they were a little better than the frosting, but had the same defect of cutting down the distance. Was lucky enough to have some one break one of them and so I put on another make. These were supposed to use all the light by putting the glare part down on the road and they were a great improvement on the frosting and light spraying device I had used before. Had some trouble about adjusting my lamp bulbs in the reflector to get the light down the road where I wanted it, but when it was set right I had a light I thought was petty good. Could see more than a block ahead and pretty near the full width of the road, and there was enough light along the side to show fences and things. Thought I was fixed all O. K. until I went out on a narrow concrete road that was popular. Then I found that the fellows who were using dimmers in town and big lights in the country, with clear fronts in their headlights bothered me. The trouble was that my headlights did not throw enough light at the side of the road so I could see the edge when the other fellow's glare hit me. I do a lot of night driving in the country and I would have put the clear glass back in my headlights, but I remembered that I had the same trouble when I was using the clear glass. Asked my friends what they were doing and although among the lot they had tried out most of the "57" varieties of glare chasers on the market, they were having about the same or worse experience as myself. Got along pretty well by staying off from the main travelled roads at night, but it spoiled my fun a good deal and cut down my night rides. Finally ran across a man who said he had the dope on night driving. He put a spot light on his car and shot the light along the edge of the road. This let him see the edge right through the glare from another car and he could sail right along. Went to a dealer to get a spot light and he showed me a new lens that he was using himself. He said it did just what a spot light would do except that the light along the edge covered about five times as much territory as a spot

light would. Having "got the habit" I fell for the talk and put a pair on my headlights.

The fellow who got these up knew where the light was wanted and put it right there. The dealer was right about their fixing you so that the other fellow's light don't bother you. I never realized what a strain it was to drive at night with a partly lighted road until I tried the new scheme for lighting the road so that you can drive just as you do in the daytime.

I. A. Douglas, Milwaukee, Wis.

Likes the Prismatic Lens

A volume could easily be written on the consideration and experience of headlight attachment. Much of the pleasure of driving at night as well as the safety of motorists and pedestrians, and car injury due to roads and weather conditions depend upon the headlight equipment. Thus a sufficient headlight illumination is required to make visible at a reasonable distance, persons, road curves, narrow culverts, ditches, shrubbery and non-illuminated vehicles.

The headlight equipments usually supplied by car manufacturers are capable of supplying a powerful light for the benefit of the driver, but at the same time, the approaching and passing traffic is affected by the glare so that accidents do occur.

Accessory companies and illumination glassware manufacturers have placed on the market over two thousand methods, each of which acts partially in overcoming the defects of ordinary headlight action. These devices embody the following theories or designs: Use of dimmers, tilted headlights, auxiliary globes; parabolic reflectors with devices placed in the path of reflected light; parabolic reflectors with devices placed between the light source and the reflector; specially treated bulbs and bulb filaments; specially designed reflectors and change in the color of light. Each of these devices accomplishes a definite purpose by innumerable modifications such as diffusing lenses, deflecting lenses, opaque lenses and screens, straight lenses, prismatic, blinds, bulb canopies, metal shields, bulb filament arrangements, ellipsoid linings, double foci, slant axis, etc. The specialized effort of each is to overcome what is known as glare, which may be described as the effect produced by light which falls upon the eye in such a manner that vision is impaired and sensi-

bility temporarily reduced; and also meet other ideal requirements as nearly as practicable.

In my opinion each and every device that has come under my observation (and there have been many) has failed to be wholly efficient when state automobile laws, drivers' requirements, pedestrains' rights and other motorists are considered. We therefore must take the compromise whereby we are able to concentrate the light into a beam which shall not rise higher than forty-two inches above the ground and which shall illuminate objects two hundred feet ahead of the car and also produce a lateral light capable of making objects on the sides of the road visible. At present this style of attachment presents very little light above the car to reveal overhead obstructions or make road directional signs readable.

Relative to the maintenance and proper condition of these devices, the best efficiency is obtained from concentrated filament lamps and the ability of the driver to adjust the position of the filament in its proper focal plane, as a crooked filament stem or crooked base on the lamp will place the filament to one side and seriously distort the beam. Cleanliness of reflectors and glassware is essential.

Headlights with short focal lengths require very accurate placing of the filament and many light directing devices used with this style of head lamp complicate the focal adjustment.

A couple of popular misconceptions have arisen, viz.: That optical devices, lenses, reflectors and refractors increase light. These attachments merely distribute the light flux over a smaller area thereby increasing the beam candlepower. The colored light does not produce less glare except that traceable to the lesser intensity of the light due to the absorption of the colored glass. Colored glass does reduce the back glare through fog or dust.

The prismatic type of lens is the headlight attachment that offers the most practical of the ideal requisites of all concerned.

E. M. Jackson, Denver, Col.

CHAPTER V

THE COOLING SYSTEM

CLEANING THE RADIATOR

THE safest and most efficient method of removing scale from a radiator is to soften the scale with a chemical which will act upon the deposit and have little or no effect on the metal of the apparatus. A compound that possesses this property to a remarkable degree is tri-sodium phosphate.

A solution of this chemical is made in water in the proportion of one pound to one gallon of water. This is added to the water in the radiator, four to six ounces at a time, with the engine running to keep the water in circulation. Continue to add the solution at intervals of a few minutes until an excess is present, viz., until a little water drawn from the radiator and allowed to settle, or still better, filtered, shows no further sediment when a few drops of the phosphate solution is added.

When the neutral point has been reached, add a half pint of the solution in excess and operate the machine for a few hours. Then empty the water from the radiator and thoroughly flush out. Repeat this treatment, and afterwards always add a small amount of tri-sodium phosphate solution to the water when replenishing the radiator. If much water is lost from steaming flush out radiator about every 1,000 miles which will probably cure the trouble.

The amount to use, for waters of different localities, will vary, but can be estimated roughly as outlined above. The doctrine of prevention is the most satisfactory in treating of radiator troubles. Ordinarily, scale is composed largely of compounds of lime, magnesia and iron. When the water is fresh these minerals are held in solution by the carbonic acid gas which is always present in our natural waters, and gives them their so-called "life." Under the action of heat from the engine, this gas is quickly driven off and the minerals which it had held in solution become solids and settle onto the metal of the radiator, forming a hard crust or scale in a short time. The action of tri-sodium phosphate is to change the nature of these scale-forming minerals, transforming them into light, flocculent solids which do not stick to the metal of the radiator and harden.

Whenever possible, it is best to separate these scale-forming minerals from the water before using it in the radiator. This can be done in a tight barrel by stirring in the phosphate solution, allowing to settle, and using the clear water.

F. L. ARNOLD, North Woburn, Mass.

Small Doses of Lye

Dissolve as much concentrated lye as a quart of water will hold, drain a little water out of the radiator. Start the motor and let it run for ten or fifteen minutes. Drain off and fill radiator a half a dozen times, or until all traces of the lye are gone.

FRED H. BUTCHER, Brooklyn, N. Y.

A Vinegar and Water Solution

Disconnect both the inlet and outlet and plug them with corks. Make a mixture of about half and half ordinary table vinegar and soft water and fill the radiator with it. Let it stand for about twenty minutes. Connect one end of the garden hose with the hydrant and the other with the inlet tube of the radiator. Turn on the water and let it run through the radiator for about an hour. If at the end of this time the desired result has not been accomplished, repeat the vinegar and water treatment, and flush the radiator with water again. The flushing should always be thorough, as any vinegar remaining in the tubes will work injury in the course of time. It is safer to repeat the operation than to use too strong a solution or to leave it in too long. If one has access to a steam boiler, a helpful additional treatment is to connect the hose with a steam cock and let the steam be forced through the radiator for some time. G. W. BROWDER, Franklin, Ky.

The Acid Treatment

First plug the bottom outlet of the radiator, then pour in a 20 per cent. solution of hydrochloric acid, allowing it to stay for four or five minutes. The radiator should be thoroughly flushed and polished after this treatment.

In my six years' experience I have learned that a badly crusted radiator is usually a hopeless proposition. But when kerosene and all other plans have failed, I have found that the method explained above will give good results.

HARRY S. WEIDENHEIMER, Allentown, Pa.

Use of Caustic Soda Solution

Caustic soda has long been known as a substance which prevents the formation of scale through forming a granular and easily removable sediment instead of a dense plating on the inside of pipes and radiators. It has also been found that

this same substance will remove scale already formed. It is not exactly clear why this action takes place, since neither carbonate of lime nor sulphate of lime—the chief constituents of boiler scale—appears to be dissolved in caustic soda. Nevertheless, its action is very effective, and especially when the strength of the solution of caustic soda lies between 15 and 22 per cent.

The whole of the water in the cooling system must be drained and measured, taking care that no water is left, which would have the effect of diluting the solution. The solution must be made by dissolving 2½ pounds of solid caustic soda for each gallon of solution. If five gallons is the capacity of the whole system, it will clearly be necessary to dissolve 12½ pounds of the soda. Considerable heat is generated when the soda is dissolved, and much stirring is necessary unless the soda is hung in an iron basket just under the surface of the liquid. When it has cooled, the solution may be poured into the system until it is entirely filled up. Allow it to remain over night, and draw it off early in the morning. It must be borne in mind that caustic soda will corrode aluminum or zinc, and must not be used if the system should have, for instance, an aluminum pump cover. It also acts to some extent upon rubber and brass, but it is not likely to seriously damage such fittings in one night. After running out the solution, a hose and water supply should be connected to the system and a good stream of water driven through at fair pressure for some time—say, five minutes. The solution of the caustic soda may be carried out in an iron bucket.

W. B. Gibson, East Orange, N. J.

Kerosene and Compressed Air

First, disconnect the pipes leading to and from the engine and drain off all the water from the radiator. Then fill the tank and radiator with kerosene and let it stand for at least two hours, being sure that all of the water is first drained off.

After this take a piece of hose and connect to top-pipe of the tank with the cut-out valve in the exhaust pipe (compressed air is the best, if you have it); then start the engine, running it slowly. Let the exhaust blow the kerosene out through the bottom pipe into a tub or bucket, then stop the engine, fill the tank with kerosene and again blow it out, and see how much scale is in the bottom of the bucket.

After the kerosene has been blown out, fill the tank with water and blow it out, so as to rinse the radiator. You now connect the pipes with the engine and it is ready for work.

Lowell V. Irving, Nevada City, Cal.

MENDING THE CRACKED WATER JACKET

IF the fracture is readily accessible, the removal of the engine from the chassis is unnecessary. Remove with gasoline all oil, etc., from the fracture and surrounding metal. Plug the water-jacket inlet and to the water outlet attach the end of the rubber suction pipe of an ordinary hand vacuum cleaner. Get some iron cement at a supply store. Run your engine until the crack and surrounding metal is pretty well heated and then, with a common table knife in one hand, apply iron cement paste to the crack, a little at a time, while the other hand operates the handle of the vacuum cleaner, which sucks the cement into the crack. This suction can be easily regulated to suit the width of the fracture; and as the fine part of the fracture requires more suction force to fill it, this part should be treated first, letting up on the suction as the fracture widens. Apply the cement paste a little at a time, until the fracture is completely filled.

The filling process *cannot* be done with the aid of the knife alone, especially if the fracture is fine. A hand vacuum cleaner can be rented a whole day for a dollar.

After the cement is in, disconnect the vacuum cleaner from the engine and spread a layer of the cement over and around the fracture, smoothing it down flush to conform to the general contour of the water-jacket.

Run the engine at intervals, as heat hastens the hardening of the cement, which becomes about the same color as the casting itself.

If, in the first place, it is found that the fracture to be treated is not accessible, remove the injured member from the chassis and proceed as directed above, except that the preliminary heating of the fracture and surrounding metal will have to be done with a blow-torch. Heat to a temperature of about 300 degrees. A lower heat than this is better for drying the cement after it is in, such as the heat from a furnace register or steam pipes.

After the cement has become perfectly hard, run a stream of water from the faucet through the water-jacket as a test before returning the repaired member to the car.

I have successfully used the above method on one of the badly cracked water-jackets of my runabout, which since has been run about six months. The repair is still tight.

GEORGE F. WHITE, Bridgewater, Mass.

The Rusting Method

To prevent the crack from extending further, a ¼-inch tapering hole should be drilled a little beyond each end of the crack

and then taped. By drilling a little beyond the damaged portion one is certain to include all the crack, some of which might not be visible to the naked eye. Then a screw should be inserted, screwed down, and the end filed off flush with the surface of the jacket. Overlapping the crack ⅝ to ¾ of an inch all around, a piece of sheet copper not less than one-twelfth of an inch thick should be fitted and fastened down with a number of three-sixteenths or one-quarter-inch screws. A piece of canvas coated with red lead, putty or thick paint should be placed under the copper. The patch may leak a little at first, but after standing a short time will "set," making a sure and permanent repair.

If, however, this leak is in the water space around the valves where the patch cannot be applied, it can only be repaired by "rusting" the metal with a very strong solution of sal-ammoniac. The rust will fill the crack and stop the leaking. Holes should be drilled and tapped at each end of the crack, just as if it were to be patched.

WALTER M. STACY, Glenavon, Ill.

A White-Lead Patch

Cut a sheet of iron plate so that it will cover the crack and extend about an inch on both sides and at the ends. Hammer this so that it follows the shape of the cylinder and fits closely. Next, drill a row of small holes around the edge of this plate about one and a half inches apart, and then place the plate over the crack and mark the cylinder for corresponding holes. Drill those a size smaller than those in the plate and thread them with a tap. Now, take a cold chisel and cut out the crack, making it V-shaped its entire length, but taking pains not to widen it any at its inner surface. Fill this V-shaped groove with white-lead paste; over this put some asbestos wicking which has been soaked in white lead, having it lap a little at the sides and ends of the groove. Then cut a sheet of asbestos the size of the plate inside of the holes drilled around the edge; soak this also in white lead, place it over the wicking and then fasten the plate tightly down upon all by means of screws to fit the threaded holes.

If the cylinder is painted or covered with oil, it should be cleaned before patching. After the work has been finished the patch can be smoothed down with a file and painted to add to its appearance.

It is best to let the engine stand for a few days before using to let the lead set.

RODNEY E. PRATHER. Academy, S. D.

Two Kinds of Cement

An engine cylinder need not be thrown away because the water-jacket is cracked, if the crack is not too large.

There are preparations now on the market which, when properly applied and allowed to dry thoroughly, make a very neat and effective repair and will last for several months. The best method, however, is by welding. One preparation is a black-looking powder to be mixed with water, and should be made into a thick paste and applied with a thin, flat piece of metal like a putty knife. After it has dried it may be covered with a coat of paint to hide the dull effect.

Another such preparation can be made from litharge (which is a yellow powder), glycerine and ground graphite. This should be applied the same as the prepared powder and allowed a longer time to dry and harden.

Another way to make a neat repair is to drill and tap four small holes in the cylinder and by means of small machine screws attach a copper plate and a piece of sheet packing, of most any kind, over the crack. This may be used in connection with the other methods if desired.

F. R. Shepherd, Midland, Cal.

Calking with Copper

The best way to repair a cracked water-jacket is to use the Oxy-acetylene welding process. Where this is properly done, your trouble is forever ended. Where this is not possible, I would sew the crack up with copper and calk the seam, the same as a boilermaker does in calking a boiler.

This is done by drilling holes, just large enough to cut away all edges of the crack and tapping them out to take a copper rod that has been threaded to go in them.

I would commence at one end of the crack and bore one hole, tap it out and screw my copper in, just far enough to go through the jacket. Then cut off the copper and start the next hole close enough to allow the drill to barely touch the copper stud that has just been screwed in. When this hole is tapped out and your copper screwed in, your seam will be solid copper.

Continue in this manner until the crack has been filled. Be sure you bore all the crack away at each end, then use a ball and piece hammer, or calking tool, to swell and spread the copper.

After this is done use a coarse file to dress the seam off and you have a job that is both neat and durable.

Glenn Newsome, Live Oak, Fla.

Autogenous Welding

Autogenous welding, when properly done, as any process would have to be to be used at all, will leave the cylinder as good as new, and the more responsible firms doing this work will guarantee it. In repairing a water-jacket by this "best method" the cylinder is first stripped of all its attachments, such as spark plugs, valves, pet cocks, studs, etc. The studs should be removed, as the heating process which the cylinders go through sets the studs in such a way that it makes it a hard matter to remove them at any time in the future. The other parts are removed simply to save them from being spoiled by the heat.

The jacket is now chiseled out with a round-nosed chisel, making a kind of V-shaped groove where the crack was. This groove should be just about as deep as the thickness of the metal, a little less rather than to leave the bottom open. The cylinder is now put in a charcoal oven and heated slowly until it has reached a low red heat. It is then taken from the oven and the actual welding begins. This preheating is done in order to prevent shrinkage cracks after the welding. The welding is done by means of acetylene and oxygen gases burning together in an especially designed torch. The operator applies his flame to one end of the groove, and when both sides are almost to a point of fusion he brings into the flame a cast-iron rod of good quality and it fuses and forms a homogeneous mass with the metal in the cylinder. The flame is gradually moved along and the extra cast iron supplied until the groove is completely filled up. The cylinder is now put in an oven, where it will cool slowly, so that the shrinkage will not be uneven when it is cool. The weld is smoothed off with an emery wheel and the parts reassembled. The cylinder is now painted and is ready to go back in the car, as good as new.

D. B. Stouffer, Council Bluffs, Ia.

How to Apply a Clamp

It sometimes happens that the motorist with a cracked water-jacket in his motor is unable to find a welding shop near by and is then obliged to find some temporary means of repairing the injured member. This may be accomplished in a fairly satisfactory manner by the use of a good steel band, wide enough to cover the crack well, and long enough to encircle the water-jacket. In each end of this steel band a one-half-inch hole is bored and the ends of the encircling band turned up at right angles. Now the band must be carefully placed so as to

cover completely the place to be repaired, and made to conform to the shape of the cylinder walls; then a bolt is inserted through the two holes, the lock nut put on and screwed up as tightly as possible. Owing to the terrific strain to which the steel "angles" are subjected, it is sometimes necessary to have the band long enough to overlap several inches and to curve the ends back and weld them to the body of the steel band. It is, of course, recognized that this method can only be used to an advantage on motors, the cylinders of which are cast singly or in pairs, and on these when the crack in the jacket is located on the side of the cylinder walls.

JUSTIN D. DOSBRANDT, Upland, Texas.

CHAPTER VI

THE LUBRICATION SYSTEM

WHEN THE OILING SYSTEM FAILS

TOO much oil cuts down a motor's efficiency as much as anything short of total failure in cooling, lubrication, ignition or carburetion. When the cylinders are flooded with oil, the motor is sluggish and chokes up and carbon is formed very rapidly.

On one car of 1912 model, a vacuum system of lubrication was provided. For level runs, this system worked wonderfully well, but on long hills both up and down, the flow of oil was in such excess as to impair greatly the efficiency of the motor as well as to make much smoke and carbon.

The oil was carried in a reservoir on the side of the crankcase and fed into the sump through small holes at the bottom of the reservoir. The flow was regulated by the amount of lubricant in the crankcase, for the oil could pass out of the reservoir only when air was admitted to it through the holes in the crankcase, and of course this occurred only where the level in the sump was down to the holes into the reservoir. On hills the oil in the crankcase would run to the low end, thus exposing the flow hole on the high end and allowing too much oil to pass through.

To remedy this trouble a brass cylinder, sealed at both ends, having a capacity of about three pints, was attached to the under side of the crankcase running lengthwise the car. This tank was tapped and ¼-inch pipes were run to it from the drain cocks placed on the bottom of the crankcase, the pipe from one drain cock running to the opposite end of the tank in order to avoid a reverse flow on steep hills. On the inside of the drain cocks short standpipes were attached to keep the oil at the proper level in the crankcase. Another pipe was run from the bottom of the overflow tank through a hole in the drip pan to the outside and fitted with a stop cock and an elbow pointed down. Thus it was a simple matter to set a receptacle under the

elbow and open the valve, draining out the overflow tank when necessary. A breather pipe was run up alongside the engine from the top of the overflow tank.

After some little adjusting to get the standpipes at the proper point to regulate the oil level, this attachment put an end to all the vexations of a flooded motor and at the same time increased the mileage per gallon of lubricant from 75 to 200.

C. B. T., Paeonian Springs, Va.

Adjustment That Ended Trouble

Oiling the gasoline motor to-day is more of a problem than it was a few years ago, in spite of many improvements in design. This is due to the fact that the gasoline of the present is less volatile than formerly and consequently requires better carburetion and the application of heat to obtain anything resembling a dry, well vaporized mixture. Of course, more trouble is experienced from this cause in cold weather than in warm.

Last Spring I had considerable trouble with the motor smoking, even when the level of the oil in the crankcase was kept low. I blamed it on the oil, which was a well-known product, and drew it from the crankcase. It appeared very thin and watery, so I sent a sample to the makers who reported that it contained gasoline which had probably passed the piston rings on account of running with a rich mixture. Of course, the oil being so thinned worked more freely past the rings, causing the motor to smoke. I then adjusted the carburetor to a weaker mixture, put on a hot-air stove and pipe and found that this helped so far as the thinning of the oil was concerned.

However, this did not stop the smoking, which I might state had always been a fault of the motor, so when it was taken down for overhauling, I had new piston rings of the leak-proof type installed. This improved the compression but did not stop the smoking, so it was decided
the crankcase and give the oiling mechanism a careful inspection. The oiling system is of the force feed and splash type, with pump contained in oil well. The pump was found to be in good order and all the oil pipes clear, so that oil circulated freely, but it was discovered by operating the pump that streams of oil were forced upward at an angle that would carry them directly into the cylinders instead of down into the oil troughs as the makers of the car had told me they should.

As the oil pipe was cast in the wall of the crankcase and the holes drilled into it opposite each oil trough, there was no way to make the oil flow down into the trough except by drilling new holes and plugging the old or by inserting bent tubes in the holes alredy there. It was easier to bend short lengths of ⅛-inch tube, thread and screw them into the old holes than it was to drill new holes. This was done, the tubes being bent so that the streams of oil would flow into the troughs instead of up into the cylinders as before. After assembling with these changes, it was possible to run the motor with very little smoke unless too large a quantity was put into the crankcase.

Since making these changes, in several hundred miles of running, the motor has been just as well lubricated, has smoked less and has not used so much oil, thereby decreasing the amount of carbon in the cylinders.

A. L. M., Brooklyn, N. Y.

Care That the Oiling System Needs

There are, in general, two kinds of oiling systems used on all types of motors. First, and most common, the splash system where oil is pumped from the lower part of the crankcase to a false bottom in which the connecting rods dip at every revolution.

The second, and less common type, is the forced feed where the oil is pumped into and through crankshaft, or into the main bearings and sides of the cylinders.

In either of these systems a reciprocating plunger pump or a so-called gear pump is used to move the oil from one point to another. In both cases it is customary to use the oil over and over and in doing this the oil will ultimately contain more or less foreign matter. This foreign matter is largely carbon and if the crankcase is not periodically drained and the motor rinsed with gasoline or kerosene this foreign matter will tend to clog the small oil pipes or the pump.

The gear driven pump will cause very little trouble due to clogging, but since any pump must be provided with a strainer on its suction, the strainer may become clogged, causing lack of oil to be supplied.

In general, there are two things which may be expected—clogged oil pipes or a clogged pump, due to carbon in the oil. Any oiling system worth while is provided with an oil gauge, which will indicate whether or not the system is in

operation. If the gauge does not indicate well in the middle of the scale, when the car is in operation, the first thing to do is to throw out the clutch, speeding the motor to see whether it has any effect on the gauge. Often the indicator on the gauge will hang in the corner, but a little over-speeding of the motor will throw it up. If, however, the indicator remains at zero an investigation should be made, first, to see if there is any oil in the crankcase, and second, to see if the supply pipes are clogged at any point. You will find several places where you can disconnect the pipes and then by running the motor ascertain whether or not the pump is in proper working order.

It is usually said that a motor that is receiving an insufficient amount of oil will run hot. If a driver does not notice that his oil gauge is failing to indicate, it is doubtful whether he would notice that the motor was getting hot, and it is very likely that the first thing a driver of this kind would know would be that his motor had stopped and would not run any more. In such a case he would probably find that one or two, if not all, of the bearings in the motor were burned out. Practically the only reliable information to be obtained on your oiling system is from the oil gauge. It is well, however, to periodically clean the system. Disconnect the pipes at one or more points and pump the dirty oil from the pump and pipes, then pump through sufficient kerosene to thoroughly cleanse the system; in other words, it is a whole lot better to anticipate trouble than to be looking for symptoms.

In the case of a splash system if at any time the pump fails to work on the road, and it is impossible to repair it, the car can be operated safely by putting in an excess amount of oil. Simply put in enough oil so that the level is raised to the oil pan in which the connecting rods dip. This may cause the motor to smoke, but it will make it safe to operate until you can drive to a service station.

Louis R. Lee, Columbus, O.

Troubles of All Varieties

Roughly speaking all motor car oiling troubles can be divided into three general classes—not enough oil—too much oil—or the wrong kind of oil.

To deal with the last item first, I have found that the best way to make sure of using the right grade of oil is to use religiously the oil recommended by the makers of the par-

ticular car you drive. It takes a lot of experimenting for an owner to discover which of half a dozen or a dozen different grades of oil is best suited for his car, and as the makers of the car have already done all this experimenting and on a far greater scale than the individual owner can attempt, it is only reasonable to take their word for it when they say that such and such an oil is best for their cars.

When the motor is not getting enough oil it is usually because the oil supply has been allowed to run low or there is something wrong with the circulating system—either the pump is not forcing enough oil to the bearings or the pipes are plugged or the connections are loose or the strainer is obstructed with dirt. A shortage of oil due to any cause will be indicated by failure of the oil gauge or indicator on the instrument board to operate properly, but aside from this the trouble is also indicated sooner or later by overheating of the motor, looseness of the bearings, and possibly by slight squeaks if the bearings, pistons and rings are closely fitted.

Whenever a shortage of oil is indicated it should be investigated at once; make sure first of all that there is enough oil in the crankcase or reservoir; next look to the oil pipe connections to make sure they are not leaking; if the connections are tight, clean out the oil strainer; and if the trouble persists, disconnect all oil pipes and run wires through them or blow them out with compressed air to make sure they are clear or if this cannot be done, drain out the old oil, flush out the crankcase with kerosene and then refill with fresh oil. As a last resort the adjustment of the oil pump may be altered to make it pump more oil if all indications show that the pump was improperly adjusted.

A surplus of oil can only be caused in the majority of cars by improper adjustment of the oil pump so that it pumps too much oil. This trouble is usually indicated by blue smoke issuing from the exhaust and by frequent fouling of spark plugs, rapid formation of carbon, etc. The same symptoms may be shown in case the pistons are worn or the cylinders scored, allowing oil to work up into the combustion chambers; or you may be using too light a grade of oil. If you are using the proper grade of oil and are sure that the pistons are properly fitted and the cylinder walls smooth and true, then it is in order to cut down the oil pump feed slightly.

"Wolverine," Detroit, Mich.

Present and Past

The motor lubrication problems of the present-day driver appear trivial to the veterans of 1906 and earlier.

My two-cylinder buggy "car" and my one-cylinder Rambler had splash systems supplied by that acme of simplicity, a drip-oiler set to feed so many drops per minute. As they required opening and closing, mental lapses meant burned bearings or smoke.

The next, a 1909 Ford, used the present model T system but consumed three gallons of oil every 100 miles despite all efforts. Cleaned plugs every fifty miles; motor every 500.

A 1910 Kissel used a "precision" oiler to force oil through several leads. Better, but noisy. Also, copper tubes are fragile.

A Hupp twenty used splash, as did all preceding, but attempted improvement—the throttle controlled the rapidity of drip feed to the crankcase.

A Hupp thirty-tow used a force-feed, supplied, somewhat similarly to the Ford, by centrifugal force of the fly-wheel revolving in the oil. Being in unit, the motor and gear case were supplied by the same body of oil—a commendable advance toward simplicity.

A Dodge, at present in use, uses a pump force fed with gauge on dash. Somewhat unsatisfactory for winter, though, because of exposed copper oil pipes.

In my experience, the quality of the oil and the condition of the engine, as well as the manner of its use, have greater influence on lubricating results than does the type of system employed. A low speed motor can use the splash, but a high speed motor must have forced feed.

Of the various systems—splash, force feed, and the combinations of these—every one has its merits and limitations. To secure sufficient and yet not excessive lubrication appears to be difficult, even in new motors. New motors, close fitting, should have a limited amount of light oil; a worn motor, quantities of heavy oil. Succinctly, a motor should be fed as light an oil and in as limited an amount as will lubricate. But err on the safe side.

The system, whatever its type, should have an accessible gauge to measure flow, total quantity, and its lubricating value—since oil deteriorates. Most oiling troubles result from neglect of the drivers.

The ultimate car will supply every moving part with lubricant from one common reservoir. Allah speed that day!

The symptoms of under-lubrication should easily be recognizable. A malodorous, hot, sluggish motor that may even clank or stop. Over-lubrication, the lesser evil, gives a smoky exhaust, plugs frequently fouling and an engine that quickly fills with carbon and knocks from pre-ignition.

To remedy, locate the diseased portion—then operate.

E. W. GARDNER, Webster, Iowa.

As to Ford Oiling

The splash system of lubrication as is provided in a Ford motor is usually reliable where the oil level in the reservoir is kept at the requisite height, which is midway between the two testing pet cocks, and the lubricant is of the proper consistency, a light grade for winter use and medium for summer.

Some mechanical constructional differences, however, such as variations in the metal stampings, which constitute the crankcase, cause the connecting rod ends and the flywheel to extend deeper into the oil level, with the result that the revolving parts splash the oil more vigorously than is desired. The excess oil finds it way past the pistons, into the combustion chambers, causing an unusaul amount of carbon deposit and considerable fouling of the spark plugs.

Where a difficulty of this kind is experienced, a remedy which is oftentimes effective, is to remove the lower crankcase cover, which contains the oil troughs and place an additional felt gasket around the outer edge of the plate. This places the cover about one-sixteenth of an inch lower, causing the connecting rod ends to dip less oil.

Usually this procedure overcomes the trouble which excess oil in the cylinder causes, but by using an additional belt gasket between the crankcase and the cylinder casting, when reassembling the Ford motor after overhauling, the oil sump and troughs are lowered a corresponding amount and though this distance that the oil level is lowered is slight, it is usually enough to prevent the motor from smoking, a fault which is common to engines that have been run for some time and the pistons fit somewhat loosely in the cylinders.

The tube which conveys the oil from the rim of the flywheel to the forward end of the crankcase, is a thin metal pipe which oftentimes is damaged by being bent or pushed out of place, when work is being done on the motor.

This feed tube should be examined previous to reassem-

bling to see that the flow of oil through it will not be obstructed when the motor is started.

Dirt and carbon particles sometimes clog the tube, obstructing the flow of oil. An overheated engine, a scored cylinder or a burned out bearing may result from this condition.

In the pocket which surrounds the valve springs and is covered by a metal plate, an accumulation of oil will result after the valve tappets have worn slightly in their guides.

By drilling one or two holes through the cylinder casting this oil will drain back into the crankcase rather than out at the edges of the valve covers, causing a disagreeable condition.

The splash system of this motor is suited admirably to the use of small quantities of pulverized graphite about one teaspoonful to the gallon of oil, giving good results.

The transmission with its numerous small gears is benefitted by the use of graphite for the particles of this substance are heat resisting with high bearing qualities and give better lubrication to the gear teeth than the light oil which is made thinner by the heat of the motor when it is running.

G. A. Luers, Washington, D. C.

CHAPTER VII

COMMON ENGINE TROUBLES

CARBON—ITS REMOVAL

IT is fortunate for the car owner that the removal of carbon deposits of whatever quantity and hardness is a simple job, quickly done. The methods of doing the work vary, sometimes depending on the type of engine and the extent of the deposit; sometimes on the particular success an owner has had with a certain method. Carbon may be removed by four principal methods, as follows: By the oxygen method; by hand scraping; by the use of a proprietary compound; by the use of a chain.

The oxygen method is the only one which the car owner rarely performs himself, because it requires a tank of oxygen gas. Because of this the owner is obliged to have this performed at some carbon removing station or garage where equipment of this kind is used. The work of removing carbon by means of oxygen consists of removing a spark plug of the cylinder to be treated, dropping a lighted match into the cylinder and then feeding oxygen into the cylinder until all the carbon has been consumed. This process relies for its efficiency on the fact that the moment oxygen comes in contact with a body oxidation tends to take place, and in the case of incandescent bodies oxidation or burning is very rapid. A piece of red-hot iron or steel placed in a confined space filled with oxygen would burn up like a piece of wood. The lighted match in the presence of oxygen starts one small carbon particle burning, then another, and so on until the whole mass is burned up, leaving the metal parts clean. Of course, the nozzle feeding the oxygen is moved around so that all parts of the interior of the cylinder get a good supply. There are certain points which must be observed in using this method. All extra spark plugs must be removed to protect the points, but there must not be an opening through which too much air can pass into the cylinder. This dilutes the oxygen stream. Also, where aluminum pistons are used great care must be taken, otherwise the aluminum will start burning. The use of the oxygen method is advised only for engines without detachable cylinder heads, and when the owner is in a hurry for his car. The process is, of course, quick and cheap (costing about fifty cents per cylinder), but very often, especially if an inexperienced man does the work, there are symptoms of carbon troubles after the carbon supposedly has been removed.

The fact that so many of our engines now are fitted with detachable cylinder heads which are quickly and easily removed and replaced makes the oxygen system suitable for comparatively few engines. The detachable head makes it possible to scrape the piston tops and cylinder head with hand scrapers or putty knife and the operator may see the work. It is by far the ideal and only positive method of removing carbon. All the owner has to know to do this is how to remove and attach the cylinder head. The owner need not be told how to operate the scrapers once he sees them. It is advisable after scraping to apply a new gasket between the cylinder head and cylinders. Care must be taken in doing this work that the scrapers do not cut into the metal of the piston and leave a rough spot. The metal should be left as smooth as possible. Also the carbon that is scraped off should be carefully scooped up and thrown away. Do not scrape so much at a time that particles are thrown around parts of the engine. The best plan is to cover up with cloths all parts likely to be affected by carbon particles and brush up the carbon as it is scraped. Every particle, no matter how small, should be wiped off the cylinder head and cylinders. Clean carefully around the cylinder head studs. A small particle left on the gasket seat will likely cause a leak. It is quite possible that a very hard deposit cannot be effectively removed by means of the ordinary scrapers, in which case a very sharp chisel lightly tapped with a hammer will do the work. Care must be exercised in this operation so the chisel does not cut into metal.

Where a detachable head is used and the owner wants quick work without trouble, or where a non-detachable head is used and the owner does not wish to scrape either by leaving the cylinders intact or removing them, the oxygen method or the use of proprietary compounds is advisable. The chain method also is good. There are on the market today any number of compounds which are designed to remove carbon. Some of these compounds are nothing more than kerosene or a similar product camouflaged. They have no more value than kerosene, which often is successful in loosening the deposit, which then can get out with the exhaust. On the other hand, there are compounds which have more than ordinary merit. There are no compounds which will dissolve carbon. The compounds loosen the carbon. The owner should accept only a guaranteed product and he should use it strictly according to directions. Where this is done good results will be had, as the writer can testify. Aside from kerosene and compounds, alcohol and other substances have been used with varying degrees of success. The compounds are the cheaper and better.

The chain method consists in placing a length of chain into the cylinder and then operating the engine. The rough surfaces

of the chain peck at the carbon and thus break the deposits. The chain thrown rapidly around inside the cylinder will do no harm to the metals.

Whatever we get from crude oil contains carbon or a carbon compound, and it is because we use fuel and oil in the engine or in the transmission is a hydro-carbon—a compound composed of a number of smaller compounds of hydrogen and carbon; hence the name hydro-carbon. In refining crude oil we get from its various kinds of hydro-carbons from the colorless gasolines to the black residuums. Whatever we get from crude oil contains carbon or a carbon compound, and it is because we use fuel and oil from crude petroleum which contains carbon that we have our carbon troubles.

When we speak of complete combustion or complete burning we mean that all of the gasoline mixture entering the combustion chamber leaves the combustion chamber in another form. If everything that entered also left, but in another form, the interior of the engine would always be clean. Also if the lubricating oil that splashes on to the cylinder walls and gets into the combustion chamber could withstand the terrific heat it would not break down and deposit carbon. We get the greater amount of carbon deposit in an engine from the destruction of the gasoline and lubricating oil, though we have heard it said that the dust from the air taken into the engine is responsible for some carbon deposits. I do not know of any test that has been conducted to determine the amount, but I should imagine it to be negligible as compared with the deposit from gasoline and lubricating oil. We cannot get around the fact that the carbon is in the fuel and the oil, and so long as we use that kind of fuel and oil the way we are using it now we are going to have carbon troubles, for we seem not to have learned how to use these substances so that the carbon will pass out.

The carbon from the fuel mixtures and oil deposits first on the pistons and cylinders in the form of a dust. First a single layer of this fine carbon deposits, then another over that, and another over the second, and so on until after the engine has been used some time there is a veritable incrustation of carbon over the inside of the cylinders and on the pistons. Usually the carbon first gets its hold on some rough surface or a small projection, because the smooth surfaces do not permit good adhesion, and an explosion is likely to blow off the surface.

There seems to be a vast difference between the carbon deposit from gasoline and that from lubricating oil; the latter coming as it does from the oil, carries with it a small quantity of lubricant which keeps the mass moist and non-adhesive. The carbon deposit, as a result of incomplete burning of the fuel mixture lacks this moistness, and such a deposit of long standing is

almost as hard as glass and adheres so strongly to the metal surfaces that sometimes even a chisel and hammer are required to remove it. The writer had occasion recently to examine the interiors of some twenty engines after the cars had covered over 1,000 continuous miles each. The fuel mixture in every case was the best possible, and the carbon deposits that had formed were a result mostly of the breaking down of the oil that had leaked into the combustion chamber. The deposits in nearly every case were soft, oil-moistened masses, not evenly distributed over the areas, but lumped on one side. These deposits could easily be lifted out with the fingers, and it is a matter of speculation as to the length of time such a deposit remains in a cylinder. They did no particular harm apparently and caused none of the usual symptoms of carbon, but still there was as much as three ounces in a small cylinder. In all probability the excess of oil continually over the carbon prevented incandescence from occurring, and the blowing out of oil lumps and formation of new ones kept an almost constant but harmless supply in the cylinders.

Aside from depositing on piston tops and combustion chamber walls, the carbon covers the valve seats and valve faces, and it is easy to see how the small carbon particles are actually imbedded in the metal as the valve is forced against its seat. Particles of loose carbon also work past the top of the piston and if there is room they will lodge behind the piston rings, preventing the ring from making a gastight joint. The small carbon particles make their way to all working surfaces, even to the valve stems. In addition to preventing perfect seating and operating of such parts as valves and piston rings, the carbon acts as an abrasive and induces rapid wear of the metal. Much of the valve stem wear and valve stem guide wear and piston ring wear is due to the cutting action of carbon particles. A quantity of the carbon thrown down in the combustion chamber gets past the pistons and makes its way to the crankcase, mixing wih the oil and reducing its lubricating qualities. At the same time the oil carries some of the carbon particles to interior working surfaces, such as the camshaft, engine bearings and timing gears. It may not seem as though a very fine powdery substance in the oil can do any harm, but the cumulative effect of constant rubbing of parts with carbon-laden oil between results in rapid wear. The oil strainer is not fine enough to hold out the very finely ground material, so it circulates and recirculates and does its damage. There is no telling how long an engine would last if its interior could be well lubricated all the time with clean oil.

An engine that is carbonized acts very much like a man who is constipated. Ability to do effective work is reduced; his actions are erratic at times; he may have a fever and complain

aloud. The engine acts almost in the same way, for it gets overheated, which is the fever; it lacks power, which reduces its ability to work; it may misfire and backfire, knock and do a lot of queer things which often cannot be accounted for. Quite naturally an engine may get overheated and misfire and do all these things from other causes besides the presence of carbon in large and undesirable quantities, but where the combination of knocking, overheating and misfiring occur, and the other systems are known to be all right, it is almost certain to be carbon. The knocking or complaining aloud is simply a preignition knock, giving exactly the same sound as a spark knock. The mixture simply explodes before it should, but with carbon as the cause it is due to hot particles igniting the charge the instant it enters the cylinders, without regard for the position of the pisons. In a badly carbonized engine the carbon gets so hot that it takes a long while for it to cool after the engine has stopped, with the result that even with the ignition switch turned off there is enough heat in the carbon to ignite the charge and keep the engine running. The motorist of today is fully aware that carbon is bothersome and costly, but, being powerless to change conditions, he is most concerned with how he can remove carbon already deposited and retard the depositing as much as possible.

Despite all care and precaution and the advice of all the seasoned motorists, garagemen, repairmen and advertisements, carbon does deposit and eventually has to be removed by some means, but this is not to say that the motorists cannot by neglect of certain matters cause a great deal more carbon to deposit than would otherwise be the case. Since it is known that the carbon comes from the gasoline and oil, then two things must be done. The mixture must not be so rich or so lean that too much of it goes unburned. Experiment is the best teacher here. The air to gasoline ratio is changed until the exhaust is clean (colorless) and gives the least pungency. When too rich or too lean a large portion of the carbon does not combine and this portion settles on the metal surfaces. The oil feed must be such that not too much gets onto the cylinder walls and pistons, for if too much is present there will be greater chance for some of it getting into the combustion chamber to burn, leaving its deposit of carbon. It is not always possible for the motorist to have in his control the burning of oil in the combustion chamber. Even though the correct amount of oil be used, there may be an unnatural leakage past the pistons and piston rings due to worn or ill-fitting parts. When the oil gets into the combustion chamber in this way the condition is generally called oil pumping. The remedy for oil pumping will, of course, vary with the specific deposits. I do not know of any test that has been conducted

cause.

CAUSES OF ENGINE KNOCKS

THE causes of "knocking" in a motor may be classified as follows: *"Inside Knocks"*—loose or worn connecting rod bearings; worn wrist pins; loose or worn main bearings and loose timing gears: *"Outside Knocks"*—a loose flywheel, badly adjusted or worn valve tappets or push rods; magneto or pump couplings loose or out of line; and the *effect of heat and pre-ignition.*

A loose or worn connecting rod bearing is probably the easiest of detection—unless very bad it will only appear on the explosion stroke and will increase with the load, such as quick acceleration, or hill climbing, when the motor is delivering its full output. If very loose, it will appear at every stroke. Opening and closing the throttle two or three times, and noting if it increases with increased spark lead, will prove in a very few moments where the trouble is.

A wrist pin will cause a knock practically identical with that of a connecting rod, though it may be deeper "tone"—and the same method of detection can be employed, though it is impossible to tell while driving whether the cause be a wrist pin or connecting rod bearing.

The main bearings may cause either a simple, regular knock, or an irregular one, which is most apparent at high engine speeds, and while accelerating may cause a knock akin to a rattle. The determination of its location while driving is difficult.

Timing gears loose on the shaft will cause a knock that cannot be felt through the car, as can the knocks above, and this condition is usually accompanied by a scraping sound, due to the gear scraping on the gear case.

A loose flywheel will cause a very puzzling knock that can be felt through the car, usually regular, but the cause cannot be fixed upon with any certainty while driving.

Worn or badly adjusted valve lifts will cause a light, sharp knock that will be regular, but may vary in intensity from time to time. This knock is easily determined on account of the regularity and time, and it does not vary with the output of the engine.

Magneto or pump couplings will cause a rapid and light knock, if loose or out of line. They can usually be located by the rapidity and lightness of the sound.

An overheated engine will knock in all the cylinders and as it comes on gradually and is accompanied by loss of power and boiling of the water, it cannot fail of detection.

Pre-ignition, if due to too great a spark lead, will cause a knock evenly in all the cylinders, which can be felt through

the car, and which ceases the moment the spark is retarded. If due to carbon, or glowing particles in the cylinder, it may cease on a light throttle.

The only rule that one can apply to the detection of any knock in the motor, while driving, is to note first, its "time"—whether crank shaft or cam shaft speed; second, its intensity and "tone" (an "outside knock" will be sharper and clearer than an "inside knock," with the exception of a loose fly-wheel, which resembles an "inside knock"—and in general the lighter the tone the smaller the part that is knocking); and third, whether it increases with the speed or load of the engine, and with greater spark lead. Having determined these, most knocks can readily be located. G. M., Schenectady, N. Y.

Similarity of Sounds

Knocks in engines are easily heard, but mighty hard to locate at times, even by the most experienced. The knocks caused by excessive spark advance, pre-ignition, short pistons and improperly bored piston-pin bearings in the piston sound annoyingly alike, while connecting rod knocks either at the wrist bearings or piston-pin and main bearings knocks are similar. In another group are the hot knocks caused by lack of oil or water and knocks caused by carbon.

Some description of these knocks, together with suggestions for locating them, follows: Spark advance knock, too much lead, even metallic sound accompanied by loss of power. On slight up-grade throw spark lever toward retard, if engine not only stops knocking but shows increased power the trouble is located. Pre-ignition from carbon or other cause; same sound as above, but will not yield to retarding spark lever. Throw off ignition switch, if engine continues to fire it is carbonized.

Loose connecting rods at either end and loose main bearings produce dull, hollow knock, hardly noticeable when engine is running light, but increasing in volume as the load is increased.

Valve-stem knock caused by wear at points of contact between valve-stem and push rod. Light metallic clicking once every other revolution at all speeds and loads. Push-rod guide knock; guide wears slightly elliptical under the side pressure of the rising cam. Knocks every other revolution; about same sound as valve-stem knock, but a little deeper in tone as the guide is placed in the engine base.

Hot knocks caused by lack of oil or water; great loss of power as friction is greatly increased and piston sticks slightly at end of each stroke. Look for signs of over-heating.

BENJ. A. WRIGHT, Newport, Ky.

Knocks on the Road

Since this is really nothing more than a lesson in cause and effect, heed the following: that without at least an acquaintance with your motor it is hopeless to attempt to locate a "knock," that the volume, rapidity and continuity of the "knock" vary with the speed of the motor, and that a little logic is indispensable.

What at first may appear to be a full-fledged "knock" will often prove to be merely a loose drip pan or a part of the wiring or piping systems vibrating and striking a part of the machine. Also, there will possibly be the continuous clatter at the extreme front of the machine, caused by the failure of the starting crank ratchet to disengage entirely.

There is one shining axiom for the motorist—remedy a "knock" immediately. It will be found that the trouble grows more serious as we go from the light "knock" to, in the vernacular, the "thump" or "pound."

As a rule it will be easier to locate the "knock" by disengaging the clutch for a short distance. Practically all "knocks" are more evident at high motor speeds, but a light "knock" will be readily located at low.

The light "knock" coming from oil or water pump will be caused—by the presence of foreign matter, by broken parts or irregular wear or by imperfect alignment of shafts or gears and sometimes, in the piston or plunger types, a slightly louder knock will be occasioned by a stuck, bent or broken plunger.

Of much the same volume as the latter will be the steady magneto "knock" due to imperfect connection or alignment of the magneto and driving shafts or gears.

A slightly sharper "knock" or "slap" from the valves is nearly always due to too much space between the push rods and valve stems. It is designated "noisy tappets." Outside of this the trouble will usually be due to a weak or broken spring or to a lost or broken spring retainer. From this vicinity will come the camshaft "knock," due to a loose bearing or spring shaft. The "knock" may also be possibly due to a chipped or sprung push rod or a "stuck" valve.

The loud "knock" in a cylinder is usualy due to early or late ignition, otherwise to defective lubrication or to irregularly worn or broken piston rings. The slightly sharper "knock" from the same locality denotes a loose or broken wrist pin or a loose piston. If the connecting rod bearing at the wrist pin or the wrist pin bushings, are loose or uneven, a duller "knock" or light "thump" will be noticed. A loose, gritty or imperfectly aligned connecting rod bearing, a bent connecting

rod or the presence of a bolt, etc., in the crankcase will cause a very loud "knock" to emanate from the crankcase. The "knock" will develop into more of a "pound" if one of the crankshaft bearings is loose or gritty, or if the crankshaft is sprung. Very seldom a "knock" or, rather, "thump," that seems to fill the whole base of the motor will be noticed, due to the slightly imperfect alignment of the motor or flywheel, or, perhaps, to a loose flywheel.

The cause and location of a "knock" are almost coincident and the remedy suggests itself, so there is no reason whatsoever for allowing any "knock" to go unattended to.

F. S. SALTER, Detroit, Mich.

LOCATING TROUBLE BY SOUND

WEAR and looseness about those parts of an automobile not connected with the power plant and transmission are generally detected without much difficulty. Their first evidence is almost always a rattle or squeak whose exact location, if it stops when the car stops, is readily traced simply by shaking the suspected parts. Among these are mud guards, external brake bands, distance rods, etc. Noises of this character are not necessarily serious in the way that engine noises are serious, since they do not indicate destructive damage; neverthelss they are annoying and they tend to drown noises of greater significance. For this reason they should be suppressed promptly.

Faults in the engine must generally be located, or at least approximated, by sound. A quiet running engine, if it develops proper power, is not likely to be much out of order. As the engine is the most costly part of the car, it is the most important part to keep in order, and for that reason any unusual sounds emanating from it call for prompt attention. The principal abnormal engine noises may be listed as follows:

Crank and wrist pin bearing knocks; main bearing knocks; pre-ignition knocks; valve clearance knocks; valve lifter side knocks; cam shaft bearing knocks; loose bushings in pump, or loose pump or magneto gear shaft bushings; timing gears worn; magneto drive loose; magneto shaft bearings loose; weak exhaust from cutout due to compression leaks; misfiring or irregularly timed explosion; loud exhaust with weak power due to retarded ignition.

These various kinds of noises are identified by the character of the sound, whether heavy or light, sharp or muffled, etc., partly also by its frequency as compared with the running period of the engine, and still further by noting whether the

sound is loudest at low or high speed, and under reduced or open throttle. Experience is very necessary, and even an expert may at times be puzzled.

List of Causes

To take the list in order, the reader is particularly cautioned against jumping to the conclusion that any knock he hears may be in the principal bearings of the engine. It is important that such a knock, when it occurs and is definitely traced, should be corrected, but it is equally important not to "monkey" with these bearings till the need for doing so is established. A crank or wrist pin knock is likely to be most noticeable under two conditions; when opening the throttle to pull uphill, and when the engine is running very fast. Such a knock, if only one bearing is involved, will at low speeds occur at every other revolution, i. e., when the explosion occurs in that cylinder. At high speeds the same may be true, but owing to the confusion of other sounds this cannot always be determined. To test the matter, cut out the spark from one cylinder after another. When the explosions are stopped in the cylinder affected the knock will cease also, If the looseness is material this test can be made with the clutch open and the engine running idle.

A knock in one of the main bearings is less common than the above. When it occurs it is most likely to be located in the front bearing, owing to the weight of the flywheel holding down the rear end of the shaft even though the rear bearing be loose. If a jack can be put under the front end of the shaft and worked gently up and down, it will show whether or not the front bearing is loose. If that bearing is snug the intermediate bearing or bearings may be affected. In this case also cutting out the spark will stop the knocking, though if the intermediate bearing is affected the two adjacent cylinders instead of one will have to be cut out. In this last case the knock will be heard once for each explosion in the adjacent cylinders.

Before taking down the oil pan to trace a knock in the main or connecting rod bearings it is best to make sure that the knock is not elsewhere (see following paragraphs). If everything else appears to be all right the loose bearing can be located by removing the oil pan and feeling carefully of the bearings in turn. A jack under one of the cranks next to the suspected main bearings will show whether that bearing is loose. Looseness on the crank pin may be detected by grasping the crank with one hand and the rod with the other, and working the rod endwise with some force. Every connecting

rod has some end play on the crank and wrist pins, and this must not be confused with radial play of the bearing. A very slight looseness, only enough to be felt through the cushion of oil in the bearing, is sufficient to produce a knock.

Pre-Ignition Knocks

Pre-ignition knocks are sharply distinguished from bearing knocks. They are caused by spontaneous ignition of the charge prematurally.

Pre-ignition knocks are all alike in sound, and all you have to do to find out how such a knock sounds is to advance the spark fully when the engine is pulling hard. Pre-ignition knocks include carbon knocks, spark knock, knocks caused by ignition out of time, valves out of time, mixture too rich or too lean. The symptom is a more or less sharp metallic hammering, very marked in aggravated cases and softening to a mere thump when actual pre-ignition does not take place, but the spread of the flame is materially hastened by the heated carbon deposits. An almost invariable test is the persistence of the explosion when the switch is opened. Pre-ignition is most marked when the engine is pulling hard at slow speeds, and it may disappear entirely with high speed and advanced spark.

By valve clearance knocks is meant simply the clicking due to excessive clearance between the valve stem and its lifter. The smaller this clearance the more slowly is the lifter moving at the instant it strikes the stem. An excessive clearance results in the lifter striking the stem a smart blow. It also results in the valve head hammering on its seat. The effect on engine power of having the valve open and close a little sooner or later is insignificant compared with the gain in quiet running by reducing the clearance to its minimum. Twice the thickness of a visiting card is ample for almost any engine, provided the cam is accurately profiled and both cam and roller are unworn. Wear in these parts necessitates greater clearance.

Any noises in the valve gear are most marked at high speed, but they are noticeable at any speed. Cutting ou the spark does not affect them, and the best way to trace the noise to its source is to run the car out-of-doors (to avoid echoes) and press one end of a light wand some feet long to the valve lifter housing, and the other to the teeth or chin. By trying one located (if in the last-mentioned test the valve clearance proves not to be excessive, the trouble is probably inside play of the valve lifter). Looseness of the lifter in its guide results in a clatter quite as objectionable as that due to excessive valve stem clearance. The simple remedy is to throw

away the worn parts and replace with new. Usually the fit of the lifter can be tested without taking it out, simply by shaking its upper end.

Occasionally an obscure knock may be traced to looseness of the camshaft itself in some particular bearing. This looseness results in a knock when the nearest cam goes into action. Most modern engines have split bronze bushings on the camshaft and these bushings, whose diameter slightly exceeds that of the cams, are held by set screws. By taking off the front cover plate over the timing gears and slackening the set screws the entire cam shaft with its bushings can be withdrawn through the front end of the crank case with the bushings on it. It is then easy to inspect the bushings and replace them if needed. In ordering new bushings it should be stated precisely which one of the series is wanted, since the bushings are sometimes of graded diameters to pass freely through the holes.

Other places where loose bushings may cause noise are in the circulating pump and on the shafts of the pinions driving the pump and magneto. If the pump is of the centrifugal type it may run quite loose with no more harm than some leakage through the stuffing box, but if it is the oscillating or eccentric type its rotating member will wobble if the bushing is loose. Similarly loose bushings on the pump or magneto gear shaft will cause noise if there is any tendency to oscillation.

Backlash in the timing gears, whether due to wear or to imperfect fitting, will cause noise, especially at low speeds, owing to the tendency of the valve springs when descending to accelerate the cam shafts. Unless the gears are materially worn this is not a serious matter. It is, however, to be borne in mind that the effect of wear anywhere in the valve operating mechanism, from crank shaft to valves themselves, is to retard the opening and retard the closing of the valves. In an old engine the cumulative effect of wear in the timing gears, the cam shaft bushings, the valve lifters and guides, coupled with the excessive clearance required by wear, all combine to change the valve timing very materially.

Magneto Knocks

If the flexible coupling through which the magneto is driven is at all loose, the slack in it will be taken up twice in every revolution, and if the coupling is broken or defective a pronounced knocking may result. In the days of plain bearing armatures it sometimes happened that the bearings wore down to such an extent that the armature actually struck the

pole pieces. With the present ball-bearing armature only destruction of the ball bearing could permit such an occurrence.

A very good imitation of misfiring is given by an engine, especially if small, with leaky valves. It does not take much of a leak to put a cylinder practically out of business, except at high speeds. When the cutout is opened the resulting absence of sound from the leaky cylinder strongly resembles that due to failure of the spark. The simplest test is to open all the compression cocks save one, and test the compression by cranking with the switch open. Actual misfiring or irregular ignition may be due to the timer wobbling on its shaft, or to the timer contacts being worn, or to the contact maker or the magneto being out of order. These are things which the intelligent owner can investigate for himself. They do not need to be matters of shop expense unless he so chooses.

Abnormal sounds in the transmission or drive system generally are fewer and more easily traced than those in the engine, and unless pronounced the injury caused by temporary neglect is not so costly. A square shaft drive between the clutch and the gear box may sometimes "get in step" with engine when worn loose, and the resulting knock has the sound of an engine knock. A square jaw coupling between the clutch and the gear case frequently causes annoyance, though no damage, by its rattling when the clutch is released or engaged. The noise is easily stopped by riveting in pieces of leather on the non-driving sides of the clutch jaws to fill the space.

Watch the Gear Case

Noises in the gear case itself are mostly due to one of the following causes: worn gears, shaft loose in bearings, and sprung shaft. Worn gears call for no special comment, save that to replace them sometimes requires appliances such as an arbor press, which the amateur may not have. The bolts which hold them to their flanges must fit their holes perfectly and be headed over after screwing up, otherwise they will work loose. Loose bearings are best investigated by cleaning the grease or oil completely out of the gear case and washing it clean with gasoline or kerosene. If the bearings are plain they are easily scored by steel grit from the gears, unless special provision is made to keep the grit out of them. Though looseness in these bearings may not seem to do any harm, it results in the gear teeth not bearing squarely against each other. As the gears are very hard and the shafts very stiff, the effect of this is to localize the pressure at the ends or corners of the teeth, which therefore

wear away rapidly. A gear thus deformed may be considered useless. The chief value of ball bearings in the gear case is not so much the reduction of friction, but the fact that they keep the gear shafts accurately aligned and do not themselves need frequent replacement. Badly worn plain bearings cause a frightful jarring, grinding and jumping of the gears when using any but the direct drive. When the transmission gets in this condition, the only thing to do is to "scrap" both gears and bushings.

A sprung gear shaft results in a pulsating noise from the gears which is unmistakable. In the rare cases where one is in doubt whether a certain noise comes from the engine or the transmission, the seat of the trouble can generally be located by noting whether or not it continues when the clutch is released, and whether or not it shows change when some other gear is engaged. If a knock is heard when the gears are in neutral with the clutch engaged, it may be due to looseness in any of the gear shaft bearings except the after bearing of the sliding set, or it may be in the joint or other connection between the clutch and the gears. A stick held between the gear box and the chin goes far to locate the noise.

WHEN THE MOTOR MISFIRES

MISSED explosions in the action of the gasoline engine of multi-cylinder type used in automobiles constitutes one of the most exasperating troubles that tend to destroy the happiness of an automobile driver.

The reason for the mental disturbance caused by misfiring is due to the frequent elusiveness of the cause and consequent inability to remedy the trouble.

The first requisite in solving this problem is to know the possible causes that must be considered in order to arrive at a correct conclusion, so that direct effort may be facilitated and useless tinkering be avoided.

The following arranged system offers a means to that end:

No. 1. *Irregular Ignition.*—Loose electric connections. Fouled spark points. Faulty spark gaps (current contacts).

No. 2. *Faults of Spark Plugs.*—Carbon or oil deposits. Leaking gaskets, or porcelains. Improper spark gaps.

No. 3. *Compression Faults.*—Too high for the voltage. Worn or broken piston rings. Piston ring gaps in line. Loose spark plug. Leaking valves.

No. 4. *Electric Faults.*—Jarring together of conductors.

Worn high tension cables. Moisture in magneto distributor. Break in wire of tension coil. Burned out spark points.

No. 5. *Faults of Valve Action.*—Improper seating of push rods. Carbon deposits on valve surfaces. Gummed push rod bushings. Warped valve stems. Burned surfaces on valves and seats.

No. 6. *Faults of Cooling System.*—Clogging of water chambers, etc. Pump inefficiency. Empty radiator.

No. 7. *Carbureter Faults.*—Irregular mixture at different speeds. Lack of free flow. Bottom of gas tank too low.

No. 8. The use of improper substances to remove carbon desposits from cylinders, resulting in scoring of cylinder walls, bent spark plug points, and loose granular matter in cylinders.

No. 9. Uncovering of concealed "blowholes" in cylinder walls by piston wear, resulting in leaks of water into the cylinder, or compression.

No. 10. The use of improper lubricating oil.

A. D. Hard, Marshall, Minnesota.

Causes Many and Varied

The missing of explosions occasions much annoyance and waste and does the car no good; the causes are many and varied; some are common and easily located, while others are obscure and rarely encountered.

Probably the sooted spark plug is the most common cause of missed explosions, especially with the beginner who has not recovered from the supposition that more gasoline gives more power. The detection of this trouble is sometimes complicated by the fact that soot may be deposited on the plug at certain throttle openings and burn off again at others, owing to inherent imperfection in the carbureter or because the user does not regulate it properly. Much could be said on the adjustment of carbureters; it would be out of place to attempt to cover the ground here, but reference to the subject may furnish a hint to those who need it to look in that direction. An external spark gap may be used to make the spark jump between the plug points, but it is by all means better to remove the cause of sooting and thereby gain power and also save fuel at the same time.

Other causes of missing are weak battery; loose primary circuit connections; primary wires not well insulated; timer worn or loose. In Ford cars the vibrators may not be in good adjustment; vibrator contacts in need of dressing; poor timer ground; warped switch base.

There may be a leak in the high tension cables; to find this they should be examined in the dark with the engine running.

The spark plug points may be either too far apart or too near together; 1-32 to 1-64 of an inch is the distance often recommended. Water may be between the plug points; the plug insulation may be cracked or punctured; the spark coil may be broken down.

There may be too little or too much gasoline fed; the gasoline may have water in it; a gasoline pipe or some small passage in the carbureter may be clogged; it can often be dislodged by opening the needle valve a turn or two and then closing it to the ordinary position.

Leaky inlet valve; inlet valve spring weak; leak around the inlet valve stem; lack of valve stem clearance; valve stem gummed; inlet valve setting not right; a leak in inlet manifold.

Exhaust valve leaking compression; exhaust valve spring weak; too little clearance between exhaust valve stem and tappet; exhaust valve set wrong; exhaust choked, probably by clogged muffler.

Broken, worn or gummed piston rings; piston ring cuts in line; piston head or cylinder interior worn, cracked or scored; lack of cylinder lubrication.

The magneto may be at fault; to test for this use the battery instead of a dual system is used.

Obstructed air passage; perhaps from dust-clogged air strainer; too small opening in manifold gasket; this unusual trouble was found on a car which ran regularly until it went to a repair shop where the faulty gasket was put in.

It will be frequently noted that at certain speeds the engine will run with perfect regularity, while at others it will persist in skipping. It will invariably miss if throttled enough, and this is not to be wondered at when we remember that the exhaust is at best far from complete and that with an engine having an ordinary compression space 25 per cent of the "pure" charge is, under the best possible conditions, composed of burned gas, and if throttled to take in only one-third the capacity of the cylinder there are equal parts of burned and fresh gas. This large proportion of foul gas, together with lack of good compression (an unavoidable feature of throttling), ignites less readily than the normal charge, and if the throttling is carried very far skipping is sure to follow, especially if for any reason the motor is at all predisposed in that direction. As the throttling greatly encourages air leakage around inlet valve stems and at all other possible places it is really surprising that the missing is not more serious than it usually is.

FRANK N. BLAKE, North Adams, Mass.

MISFIRING AT LOW SPEEDS

IF the engine is being sparked by a magneto, the speed of the magneto may not be great enough to produce a spark of sufficient intensity regularly to ignite the cylinder charges. Much trouble is encountered if the battery is weak, or if battery connections are not clean and tight. In all systems the battery supplies ignition current below a given engine speed and if the battery is weak or the feeding wires not tight, well insulated and have clean terminals, the spark will be weak and misfiring result. Certain battery ignition systems have characteristic troubles which the instruction books go into at length. If the engine is running slowly on a wide-open throttle, the resistance to the passage of the spark within the cylinder is much greater than when the engine is running slowly with the throttle nearly closed. The power and intensity of a magneto spark is very much less with the magneto revolving slowly than when revolving rapidly.

Having ascertained that a good spark is occurring in the cylinder, the fault may be in the carbureter. With a carbureter having a mechanically varied needle valve opening and an automatic auxiliary air valve, at low engine speed and wide-open throttle, the carbureter will frequently supply too rich a mixture. The remedy is properly to adjust the device which mechanically varies the needle valve opening; or if this does no good, the tension may not be right on the auxiliary air valve spring, it probably being too strong. The adjustments and the order in which they should be tried depend on the make and form of the carbureter, and the best suggestion would be to write the maker asking his instructions how to overcome the difficulty in the simplest manner.

With the present low-grade gasoline in use, with the engine idling on an almost closed throttle, great variations exist in comparatively short periods of time in richness and condition of the mixture passing to the cylinders. The throttle valve has a tendency to throw any liquid drops coming from the carbureter against one side of the manifold. This liquid will creep along the walls and along the outer radii of all the curves and one or two cylinders in the engine will get a mixture too rich, while the others get one too lean. The remedy under such conditions is to hot-jacket the carbureter around the throttle valve and the inlet pipe for the first six or eight inches from the throttle.

If the faulty running occurs at low engine speed and wide-open throttle, and a strong fat spark exists, and the carbureter is supplying a mixture having the proper proportions of air and gasoline, the trouble may be due to entrained drops of

liquid gasoline and the uneven distribution of the manifold, which can be corrected by applying heat exactly as above.

The compression may not be uniform in each cylinder, due to leaky valves or leaky piston rings. The remedy is to regrind the valves and put kerosene in the cylinder over night. If the rings are prevented from properly expanding because they are gummed up with oil, the kerosene will put them in good condition. If the openings in the rings are all in the same vertical line, or one or more rings are broken, it will be necessary to remove the piston to remedy the trouble.

In the case of leaky valves or rings, at high engine speeds, the leak might not be of sufficient size to make any appreciable difference. At low engine speeds, due to the greater time allowed the gas to escape through the leak, the result will be very noticeable. W. Rogers Wade, Tyrone, N. M.

Compression Effects

An engine which works well at ordinary speeds may miss when running slowly, because of one or more of the following reasons:

An air leak somewhere between carbureter and cylinders, perhaps around worn inlet valve stems; this will dilute the normal mixture more at low speeds than at high, and if the engine is running slowly because of being throttled, the greater suction increases the leakage at the very time when, because of reduced "gas" supply, the most harm is done.

At low speeds and open throttle the compression is greater and sparking is thereby rendered more difficult; with an indifferent coil, a weak battery, or with most magnetos this is a real but sometimes unrecognized trouble.

The carbureter may be unsuitable for low speeds, or it may lack proper adjustment and at such times give either a too lean or too rich mixture; varying the supply of gasoline or of air will settle this point.

Frank N. Blake. North Adams, Mass.

Compression and Carburetion

When running slowly on a level road with the throttle almost closed, the engine will frequently miss an explosion in one or more of the cylinders, but the same engine generally will climb a slope under a load at low speed with the throttle partly open without missing an explosion.

Often it will be found that some of the valves are leaking slightly and the engine, when running with almost closed throttle, will take in only very small charges of a weak mixture, and these small, weak charges will then partly escape through the leaking valve, so that there is very little left for

an explosion, while the engine running slowly with open throttle, and thus taking in almost full charges of a richer mixture, will have enough compressed gas of good quality left to give a fair explosion. C. Feig, Armstrong, B. C.

LOSS OF COMPRESSION

EVERYONE who is acquainted with the joys and sorrows of motoring will realize that loss of compression is nothing to be looked forward to. Its causes are numerous and in some instances hard to locate and remedy. Some of the most common are:

1. Pitted or worn valves or seats. This condition exists in all of the cylinders, particularly on the exhaust side. The only remedy is to thoroughly cleanse and then grind with some sharp abrasive—carborundum mixed with heavy oil does the job thoroughly and well with the least exertion—until the valve and its seat show up bright and clean, with no small spots. A piece of cloth or waste should be inserted in the valve pocket, so that none of the compound will enter the cylinder, as it will have the same effect on the polished wall as it did on the valve, causing no end of trouble and eventually renewal of the parts.

2. Particles of carbon or grit, lodged on the valve seat, preventing the valves seating properly. This is remedied by washing the valve seat off and if it is found to be pitted, grinding in as described in No. 1.

3. Insufficient clearance between valve stem and tapped rod. It should be adjusted so that a visiting card can be inserted.

4. Leak in thread or gasket of spark plug, valve cap or pet cock. A hissing sound is the result, which can be traced by putting soap water around the above parts and noting where bubbles form.

5. Valve stem bent or broken, thus holding valve from its seat. This can be remedied in the former instance by straightening stem in a lathe, but in the latter case only by renewal of the part.

6. Broken or open pet cock, causing a loud hiss.

The more infrequent causes are:

1. Insufficient lubrication in cylinder, causing undue wear. Knocking results and in some instances, squeaking. The oil level in crank case should be looked after.

2. Worn or broken piston ring, which cause is located by hissing in the cylinder. The offending cylinder can be found by turning the engine over by hand and noting which cylinder offers the least resistance.

3. Cylinder scored by loose wrist pin or broken piston ring,

causing hissing noise, and can be traced in the manner above described.

4. Cracked, broken or worn piston or cylinder, remedied in the latter case by having the cylinder reground and in the former two by either getting a new part or having it welded by the maker or some responsible concern.

5. Broken or warped valves, which can be traced by examining the valves carefully. FRED H. WELLS, New York City.

Prevention Best Cure

In the order or the frequency of their occurrence, the causes of poor compression are as follows:

Pitted and leaky valves.

Gummed piston rings, with an accumulation of carbon behind them.

Cylinder joint leaks.

Piston ring ends getting in line.

Worn cylinders and pistons.

The remedies to be applied are quite as simple as is the statement of their causes and the systematic application of preventives, for the first two will of itself afford a process of elimination that will make the discovery of the more serious causes easy.

For leaky valves there is, of course, but one remedy—grinding, which should be done every 1,500 to 2,000 miles, though I have driven a car 6,000 miles before there was a perceptible falling off in power. However, the result of this negligence involved the purchase of new exhaust valves, which would not have been necessary had the grinding been carried out systematically.

To prevent piston rings becoming gummed the motor should be given a dose of kerosene, applied through the pet-cocks.

The use of a graphite preparation in the lubricant, in suitable proportions, will make a very perceptible improvement in the compression of a motor, and the betterment will naturally be more apparent on an old car. It will also affect a marked economy in oil and keep the motor in better condition.

When a motor that is regularly cleaned with kerosene, lubricated as mentioned and has its valves ground regularly, shows a serious loss of power, the lack of proper compression may safely be ascribed to the piston rings having worked into line, or the cylinders having worn to a point where the pistons are unduly loose. With the modern type of pinned or composite rings the former is a rare fault nowadays, so that the cause is narrowed down to plain wear, granted that other causes are not at fault, such as wear of the valve stems, push rods, etc.

RICHARD WRIGHT, New York.

Classifying Causes

Faulty cylinder compression is caused by the following troubles, which, for convenience in locating and remedying, can be divided into two groups.

First, leaky spark plugs and priming cocks, valves not seating, caused by bent or gummy stem or lack of clearance between valve stem and the lift, gummy piston rings.

Second, leaky valves (warped, cracked or carbon on the seat), broken or worn out piston rings, cracked piston or cylinder.

The troubles of the first group can be located and remedied without dismantling the engine, while any of the second group necessitates the removal of part or the entire faulty cylinder. However, in any event, the first thing to do is to locate the faulty cylinder by the following method: Crank over slowly without spark until the weak compression is felt, then switch on the vibrator and find the "juicy" plug by touching or using a screw driver; this gives the bad cylinder.

Now squirt cylinder oil around porcelain and threads of the plugs, and in and around the priming cock, start the motor, any great amount of bubbling or blowing will reveal the trouble, the remedy is obvious.

If the trouble is not here, next examine the valve stems. If they are gummed or bent they will stick up when the motor is turned over. Kerosene will cut the gum; straighten if bent. Test the clearance next. Crank over slowly until the lift is at its lowest position, then if there is sufficient clearance a piece of paper can be passed between the stem and lift; if not, adjust to the thickness of a visiting card when the engine is cold. Nothing wrong with the valves, the piston rings may be gummy and stuck in their grooves. These can be loosened by squirting a gun of kerosene into the cylinder. If it is certain that none of the first division troubles is the cause of the faulty compression, proceed to the second. Remove the exhaust valve of the bad cylinder. If not found cracked or carbon on the seat, clean with gasoline and mark around the seating surface with a lead pencil or chalk, replace the valve, turn around a few times and remove. Any mark left on the surface indicates a leak. Grinding is the remedy, or in case of carbon, scrape off. Repeat above operations with the intake valve if the exhaust is not found faulty. Having made absolutely certain that the trouble is not among the foregoing causes, remove the cylinder. If a crack in the piston head or cylinder wall or a broken ring is not found, the rings are probably worn out and have lost their resiliency. This will be evident by the failure of the slots to open. These can be remedied by removing and

stretching. To accomplish this, hang over the flat head of a large monkey wrench and tap it lightly with a hammer. The cylinder may be worn oval, which can easily be determined by the use of a pair of inside calipers. In this event a new cylinder is required. PERCY L. ANDERSON, Wilmington, Del.

Many Available Tests

Faulty cylinder compression may be due to one of the following causes: Leaky inlet or exhaust valves, improper timing, leaky piston or rings, scored cylinder or leaks past spark plugs, pet cocks, etc. If the compression of all the cylinders of a gasoline engine is not the same, this can usually be detected in a four-cylinder engine by turning it over slowly by the starting crank. In a six-cylinder engine the strokes overlap, so that it may be necessary to close the pet cocks and try the compression of the cylinders in turn.

Probably the most common cause of faulty compression is faulty valve action. Broken valve springs will be noted upon inspection, but a weakened spring can be detected only by being compared with its mates. If a valve is found to be broken, be sure to recover all the broken pieces, in order that they may not do further damage. The valve seat should next be examined and the valves reground if necessary. Valves should work with perfect freedom and with practically no friction between the valve stem and its guide. The caps over the valves should be tight and these, with the spark plugs, pet cocks, and any other joints, should next be examined. Lubricating oil or soap and water may be used to detect leaks and should be applied at the joints where leakage might be suspected. To test for faulty timing, remove the inlet and exhaust pipes and place the hands over the openings while the engine is being cranked.

If there is still loss of compression, the crank case should be opened and the spark plugs removed from all the cylinders except that of the cylinder under test. If a hiss of escaping gas can be heard when the ear is placed near the crank case, there is a leak between the cylinder wall and the piston. It is possible that the piston rings may be stuck from deposits of carbon and burnt oil. Treatment with kerosene should remove this, but if it does not, the cylinder must be taken down and the walls and piston examined.

J. L. LANSING, Worcester, Mass.

CHAPTER VIII

THE TRANSMISSION

TRANSMISSION TROUBLES

A CAR that has been used for some time is apt to develop troubles; perhaps due to neglect, perhaps to faulty construction. We had numerous ones in a two-year-old car. It was equipped with a standard make of rear axle, the transmission case being cast with the differential housing, and the driving being through a torque tube bolted to the front end of the gear box and by means of a yoke on a cross member of the frame. One day, in driving up a hill, it became desirable to shift into second. When this was attempted, there was a loud "bang" and the car stopped. Investigation showed that it had attempted the perhaps impossible feat of going backward and forward at the same time, both second and reverse having gone in. The gears were shifted by two rods extending from the transmission to the cross member of the frame, on the front end of which were fingers which pushed back and forth by an extension, on the shifting lever. One of these rods had become loosened in the gear box, and had fallen over towards the other in such a way that the shifting lever pushed both of them and pushed in the two gears at the same time. The quadrant which should have prevented this had been forced out of place. A temporary repair with a bit of hay wire enabled us to reach home, and a permanent repair was made by tightening the rod with a special socket wrench.

Not long after this, while running on a smooth road, we were startled by a distressing pounding somewhere in the inner workings of the car. We got out and got under, incidentally discovering, by the fact that it went into our ear, a stream of gasoline from a leaking connection. Being then inexperienced in transmission diseases and their symptoms, we could not locate the trouble. We got home, and a repair man diagnosed it as smashed gears. We pulled the transmission to pieces and found a piece of gear tooth lodged between two teeth of the constant mesh gears. As the general condition of the gears appeared to be good, we extracted the piece, put the awkward contrivance together again, and for a while had a respite from trouble.

In using the car on rough roads, we found that second would

not stay in unless held there by main strength. Examination showed that the edges of both second gears were so worn that they meshed at an angle. A couple of teeth were also missing from first. We remedied this by installing three new gears.

Lubricant would not stay in the gear box. The gears cut paths in hard grease, without appropriating any, and soft grease ran out almost as fast as it was put in. Various makeshifts were tried; piping being wound around the propeller shaft and rags stuffed about the end of the torque tube, but without success. Finally the whole clutch assembly was pulled out, and the driving yoke dropped, the universal joint taken off, and the end of the stuffing box on the end of the shaft packed so tightly with waste that no further leakage occurred.

One day while we were leaning over the front seat of another car, looking into the open gear box and shifting the gears back and forth, it was noticed that whenever a gear was put in, the main shaft moved sideways. Taking hold of the shaft, it could be moved up and down and sideways. On removing the torque tube, the back end of which held the rear bearing of the propeller shaft, which was also the front bearing of the main transmission shaft, it was found that the whole bearing, which was annular ball, had a quarter of an inch play in the hole in which it was supposed to fit. At a nearby automobile factory a shim was fitted around the bearing which held it in proper place. In doing this work the waste which had been packed in to hold the lubricant was removed. But weary of pulling things to pieces, it was allowed to leak, and every few days the grease was scraped up from the floor boards and frame and put back in the gear box.

The rear axle did not give so much trouble. The right wheel had been allowed to run loosely, and so wore the end of the shaft and inside of the hubs that it could not be kept tight without binding against the brakes. A shim of thin iron was fitted to the taper on the shaft. This had to be renewed once or twice until the right material was obtained, and then it lasted a long time. The whole rear of the car rattled badly. The wheel bearings were so loose that the wheels hopped up and down, hitting the brakes. As the bearings were non-adjustable no remedy was applied. The rear axle hummed disagreeably. It hummed much harder going around a right hand corner than around a left hand one; but there were no adjustments of any kind on the axle, and we had to let it hum.

We have always been grateful to this car, for it furnished a school of adversity in which we learned many things of advantage in a short time, and which it would have been impossible for us to acquire in a better car.

E. A. S., West Haven, Conn.

Trouble Generally Lies in Repair Shop

Transmission troubles are very rare, but rear axle trouble, especially in the differential, is often encountered. Nine times out of ten, differential trouble can be traced to a repair man. Few cars ever have been built that were subject to differential trouble traceable to faults in construction. From experience and observation I have learned that differentials rarely give trouble until for some cause they are taken down. This may be on account of a broken axle, bevel pinion or ring gear. After the necessary repair is made and the differential assembled, then comes the "differential trouble."

This trouble shows up in various ways, such as harsh grinding of gears, heating, burning out thrust washers, breaking of differential gears, etc. And the trouble is more prevalent in split differential housings than in integral ones.

One car particularly, I have in mind, gave lots of trouble. It would run a few days fairly quietly and then it would develop a very annoying growl and grate. I happened to be present in the garage while this differential was being assembled. The differential with its protruding axles was laid on the floor. The two halves of the axle housing were slid over the axle ends and pushed up together where they were bolted. At my suggestion the workman took the housing off and one-half of the housing was placed in a vise which held it in a vertical position. The axle was slid down into it and the thrust washers were placed in their correct position before the differential was dropped in place. Then the other half of the housing was let down carefully and bolted to the first half. The thrust washers were fitted on pins. When the housing was shoved together while resting on the floor, the washers got out of place and made the differential bind.

Some differentials cause trouble after the repair man has had them out, because he allows too much side play. The bevel pinion will be barely meshing with the ring gear one moment, and then it will be bottoming the next moment.

Loose truss rods, lose differental housing bolts, running different diameter tires on rear wheels, and towing other cars will cause differential trouble.

Differentials, as the car builders turn them out, give very little trouble until they have been once taken out for repair or to get at some other part. Then if the man who does the work doesn't understand his business, there is pretty apt to be a period of annoying trouble for the car owner. The manufacturer usually has to take the blame.

GEORGE S. BROWN, Norwich, Conn.

Varying Troubles With Varying Axle Types

My first case of transmission trouble was experienced with a car having a selective gear and a live axle. I was going along a smoothly paved street when I heard a slight click under, or towards the back of the car. This click occurred several times at intervals of a few seconds or so. Anticipating trouble of some sort was imminent, I directed the car into an alley and drew up to the curb. After looking around under the car and at all of the tires, I decided I must have been nervous and proceeded to get under way again. I went through the usual motions of throwing out clutch and dropping into low, but although the motor ran perfectly and the gears did not clash, the car moved not.

I left the car and had it towed in. When I called for it the next day I found that a small key in the end of the drive shaft had worked out, allowing the shaft to turn in the beveled pinion. This, I was told, was an unusual case, but most cases of trouble are unusual, I find.

With another car, having a floating axle, I was driving along a smooth pavement at moderate speed, when I heard a great racket under the car, as though the rear wheels had run over a number of loose planks in a bridge. Again I stopped, looked at all the wheels and under the car, but found absolutely not a thing wrong. This time I got in and drove away without apparent trouble on the part of the motor or signs of distress from the transmission. However, had only proceeded a block or so before the racket reoccurred, but knowing nothing better to do, continued at moderate speed to my garage, and the following day called the service station to attend the car, telling them of the peculiar noise about the rear.

As soon as the service station notified me that the car was ready, I called to inquire what they had found the matter. The service manager took me back into the stock room and said, "You must have been in an awful hole to do this," holding up for my inspection two axle rods that had been twisted off as you would twist a piece of taffy. I told him I had not been anywhere save between my residence and the city, over the route he had driven in getting my car. "Well," he said, "in that case these axles must have been defective," and I guess they were, because I never received any bill for the job, and that was the last I ever heard from the service station regarding the matter.

However, I checked with some other owners of the same car and found that in a certain period there had been several cases of this same trouble. Evidently a number of axles had been made, by mistake, from very soft material. No doubt, the twisting had taken place at different intervals, and the first evidence

of the trouble was only the completion of the twisting off of the axle rods. The fractures were jagged ones, so that torque was transmitted to the wheels after the fractures were completed and the racket was caused by the ends slipping past each other.

These two instances are about the only cases of real trouble I have had, although I have had dry wheels and noisy gears, due to wear, and have also had trouble keeping grease inside the universal joints. These troubles, I assume, are common and trivial. The unusual troubles are the ones that will get you if you don't watch out, and I venture to say, you won't know what to do when they occur.

Louis R. Lee, Columbus, O.

CHAPTER IX

THE STEERING SYSTEM

CARING FOR THE STEERING GEAR

A SELF-LUBRICATING, automatically adjusted steering gear is apparently what a lot of motorists need. Of course, it would be very fine to realize such an ideal condition, but it is not in the cards. The steering gear comes nearer to being standardized than any other part of the car that I can think of at the present time, barring none; also, it is simple in construction—too simple on some cars where all protection against mud has been omitted. With reasonable care the steering gear will outwear the other parts of the car.

For the sake of your own safety and of those that ride with you the following conditions should be maintained:

Front tires well inflated;
Tight but well lubricated bearings and joints;
Proper wheel alignment.

Smooth tread and some designs of cord tires in front promote easy guiding of the car. Of course, the tires should be of similar size and section and inflated to the same pressure.

To locate loose connections or worn bearings jack up one wheel at a time, grasp the tire with both hands, work the wheel back and forth, noting the places in the steering gear where there is the most play. You may expect to find looseness in the bal land socket joints, on the tie rod, and also on the drag link between the steering arm and the knuckle joints. These ball and socket joints should be free to move, but it is not necessary that there should be any play in them. A little looseness in each joint will cause a lot of lost motion at the steering wheel.

Also, take hold of the top and bottom of the tire and work the wheel in a vertical direction, looking for excessive movement in the wheel or knuckle bearing. A loose wheel bearing will cause excessive wear in the center of the tread of the tire on that wheel.

With both wheels raised from the floor of the garage turn the steering wheel through its entire range and note whether

there are any tight spots. A tight spot may be caused by a poorly fitting bushing, a bent rod or steering column, or a lack of lubrication. Usually a tight spot in a used car indicates lack of lubrication, or the presence of mud or grit. There is a certain type of drop axle that is especially susceptible to the presence of foreign matter in the knuckle bearings. I have had such a car and have found it necessary to get out on the road, jack up the front axle and work grease into the bearings before it was possible to proceed with any degree of satisfaction or safety.

All of the ball and socket joints should be covered with well fitted leather covers and the joints kept filled with hard cup grease in warm weather, and a softer graphite grease in cold weather. At least every three months these leather covers should be removed and cleaned and also the joints, if there is any great amount of grit in evidence.

The wheels must also be properly aligned to insure the car holding the road, also to prevent undue wear on the tires. With the wheels directed straight ahead the rims of the wheels should point in at the front and in at the ground line. If the alignment is out the tires will show excessive wear in the center of the tread. A bent cross rod, or pivot arm, is a frequent cause of misalignment and should be evident to any one who frequently inspects his car.

The bushings and the bolt in the knuckle joints will have to be removed two or three times during the life of the car. There is also a great amount of shock and wear taken up in the steering arm, hence a new bushing will occasionally be required at this point. The essential thing to watch out for is lost motion—excessive wear in one or more parts will allow the wheels to jerk around on rough roads, throwing shocks and strains on the steering gear that are liable to cause a breakage of some part if the condition exists long enough.

Much depends upon the condition of the steering gear. It is easy to get at and not difficult to inspect. If you keep the joints filled with grease there is less chance of the mud getting in and it is easier to keep the mud out in this way than it is to get it out after it has gotten in.

Some cars are provided with roller or ball thrust bearings in the knuckle joints. I believe that this feature should be included on all cars.

On many cars the provision for lubricating the knuckle bearings is inadequate. I do not subscribe to the popular idea that the grease cups are too numerous. In the first place,

grease is the only lubricant that will hold its own against slush and mud, and in the second place, grease can be forced into a bearing while oil must flow in—if it flows in freely it may also flow out. Self-lubricating bushings should give satisfaction on spring bolts, but I doubt their effectiveness on the steering gear.

The three principal features are, therefore, plenty of lubrication, tight joints and proper alignment. Get your service station to check and adjust the alignment frequently.

Louis R. Lee, Columbus, O.

Yours for Safety

The mechanism by which steering is effected is without a doubt among the most important features of a car, if not actually the most important. The truth of this statement will be realized when attention is called to the fact that safe steering is the final requisite that has made modern high speeds possible, for without safe and dependable steering gears no racing driver would dare to run a machine at a high rate of speed, knowing that at any minute the unsafe steering apparatus might shift the control, thus allowing the front wheels to waver and the car to run into some obstruction by the roadside.

The same argument applies in an even greater degree to the case of the non-professional driver, who wants to be on the safe side even more perhaps than do the daredevils who drive racing cars. Nearly all of our roads are curved, and to make all of these turns with safety the steering gear must be reliable.

Again, in mountainous country where there may be a sheer drop at the roadside of hundreds of feet, it becomes necessary that the steering mechanism be very accurate and that it obey without delay the slightest move on the driver's part. To secure this there must be no lost motion or wear of the interrelated parts. These things mean that the whole steering mechanism must be safe and reliable; strong and accurate; well made and carefully fitted; well cared for and finally the design and construction must be based on a theoretically correct principle, for otherwise the mechanical refinements will have been wasted. When a new car leaves the manufacturer the steering gear is packed with grease sufficient to care for from 3,000 to 4,000 miles of service. During this time the grease cups should be kept refilled and at the end of 3,000 miles the worm and gear case should be refilled with a good

grade of graphite grease and it is also advisable to add a small amount of cylinder oil as the grease may not work into all of the parts. Spark and throttle levers should have a few drops of oil every two or three weeks. The hub of the steering wheel spider should likewise receive oil at the same time. If this is neglected there is a possibility of rust forming and absence of an oil cushion promotes the possibility of noise and unnecessary wear. In general, there are three ways in which wear is evidenced. The first is by up and down motion in the steering column, the second side-play in the worm gear and the third back-lash in the steering wheel. Before any adjustments are made it is advisable to see that the steering gear is at fault. This is not often the case. Back-lash frequently occurs in some part of the wheel gear linkage. When this is the case if the steering gear be tightened the parts may be pinched together, causing injury. In making steering wheel adjustment, therefore, it is advisable first, disconnect one end of the reach-rod so that the steering gear will be isolated and the adjustments made without interference of other working parts. After this the front wheels may be jacked from the ground; the various ball and socket joints lubricated and adjusted and the wheels also. All ball and socket joints should be covered with leather boots and laced tight to keep the grease in and the dirt and grit out, to prevent unnecessary wear. In the case of a long period of service the worm and gear may wear to such an extent that there is a slight up and down motion in the steering column. This may be removed by tightening the large adjusting nut at the top of the thrust bearing directly over the worm. The adjusting nut is turned until the up and down motion is removed. It should not be tightened beyond the point where the last motion is removed, as to do so would pinch the bearing and increase the friction. After this adjustment is made adjusting nut should be locked to hold same in position. Side play in the worm gear is evidenced by lateral motion in the crossmember attached to the crank. This may be removed by taking up on the screw cover, screwing directly into the inner side of the steering gear case. After a long period of service the worm gear threads may become worn to such an extent that there is play between the worm gear teeth and the threads of the worm. This is evidenced by lost motion at the crank. The remedy is to turn the worm gear until new teeth are brought into contact, and this is done in the following manner: First, loosen the clamp bolt

and remove the crank on the gear shaft; second, turn the gear one-quarter revolution; third, replace the crank and clamp it in place. By this a new quarter of the worn gear is brought into use and this adjustment can be repeated from time to time until four quarters have been brought into play. The amount of adjustment thus possible is usually more than equivalent to the life of the rest of the car. But, if all these adjustments fail to take out the lost motion the worn gear can be adjusted closer to the worm by means of the eccentric bushing carried on the shank of the worn gear. This bushing is loosened by means of a screw in the hub of the steering gear case. If this has been loosened the eccentric bushing can be turned by means of notches milled in its outer end. Due to the fact that the steering gear is commonly the first unit assembled to the frame in constructing a car it is not ordinarily readily removed. Most adjustments can be made without removal and it is not advisable to remove the assembly unless conditions make it absolutely necessary.

HARRY A. DERSTINE, Quakertown, Pa.

Better Be Sure Than Sorry

The different items in the steering mechanism which require attention are as follows:

1. The steering wheel and post. The upper bearing of the steering post should receive a few drops of oil every thousand miles. The wheel should be kept tight on the tube or post at all times, and if of the tilting type all connections should be kept tight also.

2. The worm gear and ball arm need only occasional lubrication—a "shot" of grease from a grease gun about once every three months should be enough. The thrust bearings above and below the worm must be kept tight and the eccentric bushings of the worm gear adjusted to keep the worm and gear in proper mesh and prevent back-lash. If the steering gear is of the full worm type the worm can be turned around a quarter circle on the ball arm when worn to such an extent that the eccentric bushing will not keep it in proper adjustment.

3. The drag link, which is usually fitted with spring type ball sockets at either end, requires lubrication at these points only—grease or oil every 500 miles should be sufficient. The ball sockets must be kept tightly adjusted, but not too tight, as they may bind in some positions.

On some cars it is a wise precaution to attach a stiff coil

spring between the drag link and the car frame to prevent the former dropping in case the ball sockets become loose enough to work off the ball end of the steering arm. It is also advisable occasionally to check the drag link for bends or misplacement which might allow the steering ball arm to go past center, locking the wheels in the extreme right or left position. This, of course, could hardly happen at high speeds, but would be inconvenient, if not actually dangerous, even at slow speeds.

4. The spindle tie-rod requires lubrication and adjustment only at the yokes or forks at either end, but should be checked occasionally for alignment. If bent it would throw the front wheels out of parallel and thus make steering difficult besides causing rapid wear of the front tires.

5. The spindles or steering knuckles require lubrication every 500 miles, and should be kept tight enough to prevent lost motion, although there must be no hindrance to their turning freely.

Sometimes it is possible by turning in the spindle stop screws (which prevent the wheels turning too far to either side) to shorten the car's turning radius, making it much easier to handle in confined spaces.

6. The front wheels and their bearings—ordinarily it is only necessary to grease and adjust the front wheel bearings once or twice a season.

If the hubs are fitted with small oil-holes, however, they should be given a few drops of oil at least once a week. The wheel alignment should be checked every month or two and corrected if necessary.

Wheels seldom wabble of themselves, but if the demountable rim and tire are not put on properly the tire will not run true. This will cause more or less erratic steering, to say nothing of rapid wear on the tire. It is not a very difficult matter to check over the different parts of the steering apparatus about once a month, and it is well worth while. As the old saying goes, "it is better to be sure than sorry."

E. M. F., Detroit, Mich.

CHAPTER X

THE REAR AXLE

NOISES IN REAR AXLES

NOTHING gives one a worse impression of a car—and its driver—than to hear the rear assembly making a noise like a trolley car struggling under a heavy load. This disagreeable grinding sound is positive proof that lubrication and the driver are not as yet acquainted. Once one is on speaking terms with the value of lubrication these unwelcome noises in the rear assembly vanish—that is, if one will use a little elbow grease.

I have always held that the really efficient piece of machinery is that which needs frequent adjustment and attention. The rear assembly of the modern motor vehicle is just such a piece of mechanism. True, present day engineers have so constructed the rear axle, differential, etc. that we are spared the pleasure of "getting out and getting under," but modern chemists have not been so successful in supplying us with an everlasting lubricant. Differential gears would last the life of a car were they not dependent upon the nature of the lubricant in which they bathe. But the best of oils and greases lose their efficiency in a comparatively short time, and unless the driver substitutes new oils, creaks, rumbles, and grinds are bound to assert themselves and play a conspicuous part.

The oiling parts are comparatively accessible on most modern machines. After the first plunge, being under the rear of a car is not so bad after all. Many of us prefer it to lounging in the driver's seat—but not while the motor's running.

But all noises in the back of the car are not the result of lack of lubrication. Springs, if not attended to, can be a constant source of annoyance. I have in mind a case wherein the rear assembly made such a noise that a mechanic was on the point of taking down the parts and investigating. Finally the car was taken to the Service Station. Being familiar with the particular make of car the mechanic there merely sprayed a half gallon of kerosene on the front ends of the rear springs. Presto! the noise vanished.

Now the driver performs this little operation once a week. The forward ends of the rear springs on this particular make of car are so situated that the wheels splash a little water on them when the car is driven in wet weather. Rust and dirt cause the nut to grate against the bushing with the subsequent unpleasant sound, which in addition is greatly accentuated by the sounding-board qualities of the metal springs and frame.

The source of a similar unpleasant and unaccountable noise was discovered to be merely the metal end of a strap tapping against a metal tire-carrier. Simple things—all of these! But so annoying! Brake rods, and their countershafts, may also be included among the mischief-makers. Many rattles are the direct result of side play in these shafts. Nuts and bolts are provided to take up this play. Again it is merely a matter of taking the plunge—and elbow grease.

Brake bands on the majority of abused cars are frozen. Every time the pedal is pressed the entire brake assembly creaks. If the bands are covered with dirt—as thy usually are—the first remedy is a good washing. After this the parts should be washed with kerosene. Finally all grease cups should be refilled and turned down, and the exposed joints on the bands given a few drops of engine oil. Again, Presto!—and noises vanish.

I remember having made the remark to a friend who had had considerable experience with cars, "how do you know when there is anything wrong with your car?" "Don't worry," was his reply, "you'll know when there's something wrong. A car talks to you—actually talks to you. Every little squeak and knock is an S. O. S. call."

I understand what he meant now that I drive my own car. Every working part tells me when it needs attention. I always heed the S. O. S. because I believe that by taking care of the little things the big things will take care of themselves.

I do not doubt that the majority of the answers to this question will aim to explain noises in the rear axle construction along technical lines. This is not answering the question. When gears or shafts or axles are broken or out of adjustment cars do not run; consequently there is no noise in the rear axle. It is the cars that run but which make unpleasant sounds that engage our attention. No part that is broken or completely out of adjustment can be said to be the *cause*; it is only the ultimate *result* of some cause. And this cause, as I have endeavored to show, is in the majority of

cases, lack of proper lubrication, loose nuts, or rust. Frequent applications of oil, wrenches, and kerosene will remove all objectionable noises from the majority of running cars. Without this attention cars soon become "silent twelves"—in the repair shops.

FREDERICK C. RUSSELL, Philadelphia, Pa.

Never Let the Rear End Noises Go

There are many perplexing noises from time to time about the rear end of a car probably after it has been run some hundreds of miles. One should never let any internal noises go without immediate investigation, if not attended to they may develop into serious trouble and great expense.

The most common noise is a grumble or groan not very loud, but most noticeable going around corners. Such a noise probably comes from the differential and it is a lack of lubricant. Naturally, this trouble may be remedied by replenishing the supply of lubricant.

Another noise is a grumble or groan similiar to the first, but much louder and more distinct. The cause of this noise is worn gears. It may be quieted a little by keeping the differential case full of a good grade of heavy fibre grease.

The most serious noise is a knock heard at irregular intervals. The cause of this noise is that one or more chips broken from the gears have become mixed in the grease and churned in between the cogs of the gears. The reason that this is so serious is that every time a chip gets caught in between the cogs it tends to break them off and make more chips. To detect this trouble certainly, jack up both the wheels and spin either of them, listening carefully for the unwelcome knock. To remedy this the lubricant should be removed and the housing thoroughly washed out with kerosene causing the chips to fall to the bottom of the casing. Sometimes these chips get caught in between the cogs and refuse to be dislodged with just kerosene. If this happens they should be removed with a hammer and cold chisel. After all the chips are out one should file (with a very hard file) all the rough and sharp spots on the gears making them smooth. This may prevent further trouble from leaking. By jacking up the wheels, spinning them by hand and listening carefully, making due allowance for the absence of lubricant, one can ascertain if all chips have been dislodged from the gears. When satisfied that all undesirable matter has been dislodged and washed to the bottom of the housing,

remove all such material. (The method used for this removal will depend upon the type of housing.) The lubricant may now be safely replaced.

If frequent trouble is experienced from the breaking of cogs, it may be wise to make the following change. Drill two holes one-quarter inch in diameter, about a foot from each wheel, in the under side of the rear axle housing. Take out the old grease and fill the differential case with heavy oil (gear box oil). If now any chips are broken off they will fall to the bottom of the case and not become a menace to the gears. The holes in the axle housing will prevent the oil from running out on the wheels and internal brake bands, if such exists, and the loss of oil will be found hardly noticeable. After every five thousand miles of travel, the oil should be drained off and replaced with fresh lubricant.

A very disagreeable noise is produced in wooden wheels when the spokes become loose from shrinking or other causes. This may be overcome by careful wedging or swelling, but it is best to have a wheelwright to attend to the trouble to insure a first class job.

Where the transverse rear spring as in the Ford car is fastened to the frame it may become loose and make a crunching sound. This may be remedied by tightening the nuts which connect the spring to the frame.

KENNETH M. EDEN, East Orange, N. J.

Brakes, Gears and Rims

Eliminate the noise from the rear axle assembly and you will go a long way towards making your car a quiet running one.

There are three general causes for noise in and about the rear axle:

1st. The brakes.
2nd. The gears.
3rd. The rims.

First—the brakes (consisting of the bands, levers and pull rods, all assembled and held together by small pins or bolts) and springs receive very hard usage. Exposed to mud and dust, seldom lubricated, adjusted only when they fail to work, it is small wonder the average brake is a noise producer. The brake band should just free the drum when in release position; if it does more than this it will have a tendency to flop around. When new, with all the pins tight, a loose band may not be objectionable, but as the

pins become worn the band must be fairly snug to prevent excessive movement on rough streets. The pull rods are often provided with forked ends; by taking the rod off and bending the forks together so that they will grip the levers to which they are attached a great deal of loose motion will be prevented.

Often it will be necessary to renew the springs at the back of the brake bands as the old springs become broken or lose tension.

A squeaking brake is caused by the lining becoming worn down so that the rivet heads come in contact with the brake drums. The remedy is new linings or a removal of some of the rivet heads.

Second—the gears will be noisy if insufficiently lubricated or if worn so that there is a grinding action between the teeth. A thick oil should be used on the gears, but in cold weather a thin oil may be required. Regular inspection at least once a month should be made to see that the oil is not leaking out of the axle housing. After the gears become worn, either through long use or lack of lubrication, the only remedy is a new pinion and ring gear. Once in a great while there is a type of ring gear that becomes loose on the spider and if taken in time it can be tightened up and a new gear will not be required.

Third—a good many don't recognize a rim squeak as it often sounds like a wheel with loose spokes. Remove the rim and look for bright spots where the rim makes contact with the wheel. Take a little graphite grease and smear over all bright spots and all over points of contact. This treatment may be required once every thousand miles, or at least as often as a tire is changed.

No reference has been made to noisy wheel bearings as noise from this source is usually very pronounced if present. The wheel bearings will only be noisy when broken or dry. They should be lubricated twice a year and thoroughly cleaned each time. Provision is usually made for taking up wear, but there should be just a little play in the bearing when it is properly adjusted. A soft graphite grease should be used in liberal quantity. Excess grease that works out may be easily cleaned off, but if no grease works out you cannot be sure that no dirt is working in.

Loose clips on the springs may cause a jingling noise. The secret of locating noises is to locate and eliminate each one as it first occurs. With a half dozen or more noises present the expert will have trouble in finding them all and

may recommend repairs that are unnecessary and leave the most important repairs undone.

Louis R. Lee, Columbus, O.

Pride, Patience and Perseverance

As a general rule there is apt to be more noise about the rear axle of a car than there is in the axle. Of the two, the former makes the most racket and is usually easier to correct, while the latter is the more serious.

In a new car, due to the oversight of the inspector, the pinion and bevel gear are likely to be set either a little too close or too far apart. This will give rise to a humming which increases and decreases in intensity and pitch with the speed of the car. There is no sure way of telling just which is responsible for the trouble, although the play between the gears is an indication. The setting of these gears is a cut and dried proposition. As a general rule the outer edges of the teeth of pinion and gear should be in line and if they can be seen it will help in the adjustment. It will tell whether all the adjustments can be made on the bevel gear or whether some must be made on the pinion. This trouble should be taken care of immediately for if it is not done the gears will wear slightly in their incorrect position and then no amount of adjusting will stop the noise. It may not be possible to stop all the noise, but the position of quietest operation should be selected. As the gears wear into each other the noise will probably decrease.

The better grade of cars are provided with two thrust bearings on the axle, one on each side of the differential, and one on the drive shaft. Adjustment is usually made on the bevel gear, both thrusts being moved. Care should be taken that there is neither too much nor too little play between these thrusts. Do not mesh the gears too deeply as damage can be done in a very short time. Other cars have only one adjustment and some depend upon flat thrust washers. With the latter the washers must be of the proper thickness or liners placed under them. If not corrected, gears will be stripped in time.

If the car has been run any distance it will be well to examine the thrust and radial bearings on the drive shaft as well as on the axle. A large radial bearing on the axle allows the bevel gear to move sideways away from the pinion while a worn radial bearing on the drive shaft produces the same effect as moving the bevel gear horizontally away from

the pinion. There is the added difference that the worn radial bearings allow considerable chattering, causing an irregularity about the hum.

Perhaps you unfortunately have stripped some of the teeth from your pinion and after having a new one installed have wondered how the hornest's nest got into your rear axle. A new gear will rarely work into an old one without considerable noise and if you have that trouble the only way to correct it is to get a new mating gear to the one you just put in.

Worn bearings or gears in the differential will cause a hum or groan when going around curves or corners. These gears turn so seldom that it is rare that one discovers any noise from them.

At times when going down grade with your engine just about keeping pace with the car you are puzzled by the surging which appears to take place, frequently jerking the car uncomfortably. If you have this trouble put your transmission into high, jack up one rear wheel and see how much you can turn it before it takes hold of the engine. This shows you the accumulated wear or play between the wheels and engine. It may be well distributed or most of it may be found in any one of the following places; key of the wheels, keys in the differential, worn bearing on the inner end of the axle or on the differential if full floating, worn gears or bearings in the differential, too much play between the bevel gear and pinion, due to wear or other causes, worn bearings or gears on the drive shaft, worn universals, worn bearings or gears in the gear set. Check them up and eliminate them one by one till you know the wear is taken up.

Outside the rear axle most of the racket is caused by vibration and the cure is always the same, tighten up. The source is usually found easily with the assistance of a friend having a good ear. Brake shoes, brake rods, torque rods, or radius rods are all frequent offenders. If a brake shoe happens to be dragging and no amount of adjustment will clear it, a small auxiliary coil spring can frequently be used to keep it from touching the drum.

A noise in the transmission of a car can many times be traced to the rear axle, having been transmitted to the gear set through the propeller shaft.

The three P's (pride, patience and perseverance) will enable almost everyone to have a quiet, sweet-running car, particularly as far as the rear axle is concerned.

H. A. Holmes, Youngstown, O.

Look After Motor, Clutch and Transmission

In correcting a noise in or about the rear axle, the first thing to do is to make reasonably sure of its location. Inspect externals that may be loose, worn or out of adjustment, tightening wheel or axle shaft nuts, torque members, body bolts, fenders and spring clips and shackles. Lubricate thoroughly every oil or grease cup on the axle, brakes, and springs, and see that there is ample lubricant in the differential, universal joints, and transmission. It is worth while to jack up both rear wheels using an extra jack or block. Any side-play evident in a wheel would account for a knocking sound in driving over a rough stretch. The cause of the side-play will be found in a loose or worn shaft-key for the wheel of a semi-floating axle, in worn wheel or differential bearings or washers or in a bent shaft. The remedy for the worn key is replacement. Adjustable bearings and washers may be readily restored to a normal position; but, if not adjustable, they should be replaced. Unless he has good tools and practical mechanical ability, the average motorist had better leave bearing adjustment or replacement to the service station. A bent shaft is easy to replace on a full floating axle, but in other types considerable dismantling is necessary. If the rear axle housing has been sprung, it had better be replaced to prevent injury to the new shaft and other parts.

While the car is still jacked up, it may well be run a little at rather slow speed, but in high gear. If one rear wheel is held, the opposite wheel should speed up at once if the differential is working all right. If it fail to do so and there is a knocking or grinding noise from the middle of the housing the small differential gears or their studs are loose or worn, and the entire ring gear housing must be removed to replace them.

If one wheel is let down, with a block placed in front of it, the other may safely be spun at twenty to thiry miles an hour for a few minutes while one listens "at close range" for unusual sounds. The sense of touch will aid also, for it is often possible to feel heat produced by excessive friction coming up through the housing. This is a helpful method when the transmission is located just ahead of the rear axle, for some of the general noises of these two elements are so similar that they are almost indistinguishable from the driver's seat.

The test for noise should include a rather extensive run on the road. At a good speed, with the tonneau flooring

removed, if the motor is shut off and the clutch disengaged occasionally, rear axle noises will be comparatively segregated and more easily identified.

A slight, steady hum from rear axle gears is inevitable. A steady growl of unusual volume indicates that the driveshaft pinion gear is meshing too deeply with the large bevel or ring gear, generally due to the former having slipped down or back. On many cars there is a slotted adjusting ring at the pinion gear for moving it back and forth. Some cars have a similar adjusting ring on each side of the ring gear for setting it slightly to the left or right. On cars lacking this adjustment, it may be found that a thrust washer has worn so thin that it needs replacement.

An irregular growl, varying with great frequency at uniform car speed, indicates that the pinion is probably badly worn on a few teeth, while the same faults in a ring gear are revealed by corresponding symptoms, generally occurring but once every revolution of the rear wheels. If an irregular growl persists with load and thrust bearings and washers O. K., the ring gear assembly should be removed from the axle and examined for wear, alignment, and loose rivets. An out-of-round ring gear or housing should be replaced with a new one. Loose rivets should be knocked out and new ones swedged in while red hot, which is generally a service station job.

A steady knocking or rattling sound generally results from pinion and ring gears not meshing deeply enough. The remedy is effected by reversing the method of curing the deep-mesh growl.

The loudest and most grinding noise that comes from a rear axle is a sign of a chipped or broken ring or pinion gear. The gear should be replaced as soon as possible.

One of the most disturbing noises about a rear axle is a chronic brake squeak, which, in many instances, is caused by rough or cracked lining and may be cured by a slight and uniform application of castor or neatsfoot oil or French chalk around the lining.

Careful driving and proper maintenance of motor, clutch, and transmission units have a direct bearing in minimizing rear axle noise.

DONALD MCCLEAN, Detroit, Mich.

CHAPTER XI

WHEELS AND TIRES

ALIGNING THE WHEELS

A SIMPLE and practical way of lining up the four wheels of an automobile is as follows:

Procure four, or preferably six small wooden horses, or boxes, slightly lower than the underside of the wheel hubs, and two straight-edged planks, planed also on one side and long enough to reach from just ahead of the front wheels to a foot or so back of the rear wheels.

Have your car placed on a level floor, and test each wheel to see that it runs true. The front wheels may be spun, and a test gauge held by hand not quite touching the rim while they are revolving. Any twist in the wheel will show to the eye. In the case of the rear wheels the gauge should be supported firmly. A small pointer of wood, projecting from one end of the boxes or horses, at the proper height, can be moved up close to the rim of the wheel. As the wheel is turned, any untrue running will show by the change in the gap at the pointer.

After ascertaining that the wheels run true place a plank on each side of the car suppported on the horses or boxes, so that the upper surface is slightly below the under sides of the wheel hubs. Have the planed surfaces up, and the straight edges nearest the car, and at least an inch distant from the tires. If running-boards or other things interfere, the planks may be placed higher, lower or farther away, but the position as given above will be found most convenient in the majority of cases. True these planks up so that hey are parallel to each other and to the center line of the car, and equally distant from that line. The center line of the car can be located by bisecting the front and rear frame cross members; and measuring from the bisections, as indicated by chalk marks, at the boards, will locate them parallel and equidistant.

Just back of the rear wheels strike a true angle cross-line from one plank to the other, using a square and a cord to sight across, marking plainly where this line crosses the "straight edge" of each plank. Call this the base line. From the center of each rear wheel hub, drop a line to the plank, either by plumb or square, and project it to the straight edge. These points should be the same distance from the base line,

one on each side of the car. If they are not, the difference in measurements will readily show which way the axle is out of line, and the cause of the trouble must be discovered and corrected. Before getting similar measurements for the front axle care must be taken to see that the front wheels are parallel to each other; this may be determined by measuring the distances from the straight edge to points on the rims or felloes of the front wheels, ahead of the hub, then from the corresponding points back of the hubs. These measurements will be found to be the same if the wheel is parallel with the fore and aft line of the car; and when both measure true to their respective edges they are, of course, parallel to each other. The camber of the front wheels will not affect the above measurements in any way, provided the planks are laid level with the floor.

Corresponding points on each front wheel, as near the center of the stub axle pivot as is possible to measure, are equally distant from their respective straight edges, it follows that they are equally distant from the center line. If, when the front wheels are parallel to the center line and equidistant from it, the centers of their hubs are equally distant from the centers of the rear hubs, already determined to be at right angles to the fore and aft line, we have the wheels of the car "four square." HENRY MOORE, New York City.

Paralleling the Wheels

One of the most effective ways to line up and test the alignment of the four wheels is to stretch two parallel lines, one along each side of the car, equally distant from the wheels, say one inch from the rims. This is readily done as follows:*

Take two pine strips about 1 in. x 2 in. x 5 ft. 6 in., lay them on their edges, side by side, hold them firmly together, and saw about half way through near each end of each piece, with a fine saw (first squaring across with a square), making the distance about 5 ft. 1½ in. between the cuts; now place one of the strips across the front wheels and the other across the rear wheels, and draw the lines (thin twine or fishing line answers the purpose well) through the saw cuts, wrapping the ends around the strips a couple of times to hold them. There should be tension enough on the lines so that the pressure of the strips against the tires will hold them there without supports under them, yet not so tight but that they can be shifted

*Before taking measurements as above indicated by Mr. Riley the distances between the boards measured longitudinally of the car on each side should be made to agree, since if they do not, either one or the other of the axles is out of "square" with the center line of the frame.

a little, if necessary, to bring the lines the proper distance from the wheels. Run the lines just above the hubs and as near to them as possible without touching; if the running-boards and mud-guards interfere with the lines above the hubs, then run them just below the hubs.

After the lines are placed as above, measure from the lines to opposite sides of the rim of each wheel, as indicated by letters A, B, C and D in the sketches. Any variation between the distances A and B or C and D will indicate the extent the wheels are out.

Instead of using the saw cuts to make openings through the strips for the lines, holes can be bored with a small drill or gimlet, but I consider the saw cuts better.

J. T. Riley, Philadelphia, Pa.

STRETCHING THE TIRE MILEAGE

IF the casing is old and has suffered several blowouts and the thread worn through, a lower inflation pressure would be advisable, but they should be kept pretty hard, as there is less danger in overinflation than underinflation. Don't guess at inflation. A tire pump right on the car will pay for itself in no time by increased time miles, and if one cannot afford the power driven kind the next best is one that clamps to the running board and operates with but little exertion.

With care it is possible to obtain eight, fifteen and even twenty thousand miles from a standard casing. A common source of abuse lies in running in car tracks, and under these conditions a terrific strain is thrown on the sidewall, while bits of steel are imbedded in the tread. Track frogs are very sharp and help to steal mileage.

We all realize what happens to a pair of rubbers or overshoes that are just a trifle smaller than the shoes. The sides of them turn over, allowing them to come in contact with the ground. The excessive wear causes them to break down and cracks soon develop before the soles themselves begin to wear. This is what happens to a tire when driven on the rails.

Driving on an underinflated casing, the increased action of the side walls softens the rubber cement between the fabric layers and a certain amount of devulcanization takes place. Under these conditions when a sharp object is struck a blowout results.

Inside patches put in as a result of a blowout should never

be left in for any length of time, as these are only emergency repairs. Remove them and vulcanize the blown section.

This patch acts like a piece of foreign matter between tire and tube, and is always chafing and producing friction and also throws the tire out of balance.

A neglected cut becomes a blowout. A leaking valve produces a flat tire.

The rims should be clean and perfect. The proper style tire for rim and the proper size for car is of the highest importance. Tires carrying heavier loads than those for which they were designed may develop breaking at the beads where engaged by clinches of rims.

Start and stop gradually, turn corners slowly and keep the garage floor free from oil, grease or gasoline. In case the car is not to be used for some time the car weight should be removed either by the use of wood blocks or by jacks made specially for this purpose that fit under the outside hub of each wheel.

Tighten wheel bearings to prevent their wobbling, also determine wheel alignment occasionally. Daily inspection for tread injuries, a liberal treatment of cuts of all sizes, which is done with tire dough put in at night and allowed to stand until morning.

Don't use tires on a real car that ought to be giving service on a vehicle such as a cycle car. One may use almost any oversize tire without the necessity of changing his rim equipment, providing the same type of bead is used as was originally employed.

Remember that rubber lives on air the same as humans, and given plenty of the pure kind without too much light and sunshine is a secret of long tire life. All that is necessary to remember about inflation pressures is that every inch of tire width requires twenty pounds of pure air. A six-inch tire requires 120 pounds, and a three-inch half as much. Half of the troubles come from neglecting to supply the twenty. Watch the tire gauge and take nothing for granted.

Use great caution not to skid—a bruise in the tread rubber makes a dead spot.

Shift the tires around to the different wheels, reversing them as to sides they were on originally. The strain on each wheel is different and for this reason a change is beneficial, because a constant strain of one kind is weakening. It is to be remembered that the front wheels are "toed in" and the wear does not come squarely in the center of the tire tread.

A thirty-six-inch tire will toe in about one inch. Needless to say the brakes should be used gently and equalized properly. R. L. Brindle, North Abington, Mass.

The Re-Treading Process

Faced with a shortage of tires, and with still higher prices in prospect, the question of obtaining increased mileage is becoming more commo nevery day. Tires that heretofore were thrown aside upon the first appearance of a weak spot can be made to give from one to several thousand miles additional service at but little comparative additional cost.

Of the many tire saving devices on the market today the most successful one coming within my experience provides a new tread complete for an old casing. After the original tread has been worn down to the fabric the remaining tread is buffed off and an entirely new tread, built on the same lines as that of a new tire, is cemented to the old tire carcass, thus giving to all intents a new tire. Casings re-treaded in this manner are the equal, if not better, than the factory job, having a factory guarantee of 3,500 miles. I have secured as high as 5,000 additional miles on a retreaded casing, in one instance the mileage secured being greater than that obtained from the original casing. To secure satisfactory results the casing must be in good condition, free from large cuts, weak spots or stone bruises. These treads cost less than half as much as a new tire, thus making a worth while saving.

For inexpensive tire saving equipment I have used nothing better than a good tire reliner. I have found the most satisfactory type to be those using three to four-ply rubberized tire fabric coated with a self-vulcanizing cement, which in the course of a few miles becomes a permanent part of the tire. The addition of a reliner will so strengthen the tire carcass that often 1,500 miles additional service can be secured from a casing that was previously unfit for use. For the average tire such a reliner costs about $4.00 and can be used over and over again.

Much attention has been given in recent years to devise a satisfactory substitute for air, and this eliminates many of the troubles inherent in the pneumatic tire. So far nothing has been found possessing the cushioning qualities of air. No doubt a tire filled with a substitute will give greater tire mileage, but this can only be at the sacrifice of comfort and speed. For the strictly utilitarian vehicle such a tire filler should prove advantageous.

After all the maximum tire mileage is only obtained by the careful motorist, the one who drives carefully and takes as much interest in looking after the tire equipment as the other parts of the car. The frequent use of the vulcanizer will keep tires in good condition long after they would have ordinarily worn out and places a tire in fit condition for the use of many desirable tire saving devices.

"N. A. S.," Cumberland, Md.

The Value of Re-Inforcement

Worn and damaged tires, in the experience of the writer, make excellent protectors for new tires and with their use the new casings can be made to double or even triple their guaranteed mileage. This statement is not alone attested by my personal experience, but thousands of motorists are using their old tires for this purpose and securing the same results.

The manner of applying the old casings over the new is simple. The beads of the old tire are cut off by shears or a sharp knife. This leaves the casing pliable and easily placed over the new tire. If the old tire, or protector, as it might be called, does not go over easily, use the tire iron to help it over, but as casing stretches considerably with usage it generally is no trouble.

This is done, before the tire is placed on the rim and inflated, and it is the inflation that holds it in place, while in use on the road.

The driver using reinforced tires as described is rarely inconvenienced by tacks, small nails, glass or other obstacles which commonly cause punctures. He can drive over broken stone, a lot more contentedly, and the short time required to fit these protectors is repaid many times by the service that they give.

Some owners may argue that the additional thickness would cause considerable frictionand heat up the casing; it might if the car were driven at an exceptionally high speed, but the man who wants the best milage from his tires is the one who will not open up and drive like wild.

I have tried using reliners on several occasions, but have not secured satisfactory results by any means.

If the smallest kind of a nail hole were anywhere in the casing, it was only a matter of a few hundred miles running before the reliner shoved through and put the casing beyond repair. The cause of this is plain when we consider the conditions: with a reliner in place the tire rolls, and when the

hole goes down on the road the tire deflects; this opens it up on the inside, the reliner having the pressure of the tube on the inside seeks to get out of the hole as the tire rolls up and over it chafes. This occurs at each revolution of the wheel and it is slowly but surely opening more and more each time. If a casing is serviceable it is better to have the hole vulcanized or a section put in; if its condition does not warrant repairing it, then put your repair money into a new casing and use the old one as a protector.

GEO. A. LUERS, Washington, D. C.

Systematic Care Wins

The best time to start tire conservation is when a tire is new; but, no matter what good care a tire may have received, there comes a day when the irregularities of road, weather and service leave their marks on it. The motorist who studies these signs of wear will find a number of conditions which he should immediately treat or correct, or let a competent tire man do the work, if he wishes to get the last mile out of each tire.

It is well to care for the simple and obvious tasks first, such as jacking up and thoroughly cleaning the tire and giving it a close inspection. Practically all cars have the same size tires front and rear now, so, after about 3,000 to 4,000 miles, it is advisable to change the tires around, exchanging the more worn rear tires with those on the front wheels, and the more worn right wheel ones with those on the left.

There is a rather common idea that, as a tire grows old, it should receive less than the prescribed inflation pressure that it took when new. It should not be forgotten that it is heat, from friction on the road, that passes to the inner tube, causing severe expansion at its weakest point and eventually bringing on a blowout, which is the worst accident that can befall an old tire, and generally the last. Therefore, unless the inner tube has been extremely patched or vulcanizd or shows many fine surface cracks, the old tire deserves the same pressure it had when new. With normal pressure, there is less tread exposed to the road, of course, less chance of puncture and less strain on cuts or blisters around the tread or the side walls.

When running on old tires, it is best to favor them all that one can in driving by taking bad ruts or bumps very slowly and making starts, stops and turns gradually.

For old tubes, I always carry an extra valve or two and several patches in the kit, while one or two inside and outside blowout patches give a feeling of security with casings that are "nearly gone." A little cement and dough are helpful for "doctoring" cuts in old casings. If a preparation of the white or grey paint recommended by tire makers is applied to worn casings occasionally, it tends to protect the resiliency and strength of the treads, besides concealing their age.

If an owner has the time and inclination, he may get good results from the use of a vulcanizing outfit. There has been considerable improvement in small vulcanizers lately. Heat regulation has been made easier and more positive, and holding clamps and molds have been improved.

DONALD MCCLEAN, Detroit, Mich.

A Stitch in Time

No other one item in the upkeep of the motor car is so expensive as tires. Since this is true, the motorist should give extra consideration to the purchase and repair of tires.

Let us start from the first and consider the repair of damages in the order that they are apt to come to new tires. First in order comes punctures, as tires in good or bad condition are always liable to be punctured. I have tried many so-called "puncture cures" and various patches, but have found that rubber back self-vulcanizing patches and small vulcanizers using prepared patches and fuel are the most satisfactory for ordinary punctures.

Small cuts in the tread are apt to be bothersome, for, unless they are closed, water and dirt work through them to the fabric. Soon the fabric and the tread separate and sand blisters and blowouts are the result. Small cuts may be filled with cut filler, but larger holes should be vulcanized. If you have plenty of time and a desire to make repairs yourself a small portable vulcanizer is very satisfactory and will soon pay for itself out of the saving in the rapirman's bill.

Unless you have taken care of the cuts as stated in the preceding paragraph, blowouts are next apt to trouble you. A temporary repair can be made by inserting a blowout patch and new tube in the casing. Upon return home the casing should be immediately repaired by a competent repairman.

There are many methods backed by overdrawn claims for putting a new wearing surface on a casing after the original tread has worn off. I have tried several; a rim cut casing simply slipped on over the worn casing. This method did

not prove satisfactory, for, upon turning corners and driving over rough roads, the over-casing would slip sideways and work loose. Another method is to have an old casing sewed or riveted on over the worn casing. This, too, proved unsatisfactotry, for the rivets or sewing soon broke or tore through and left the over-casing loose.

But after all this experimenting I at last found a process that has proved entirely satisfactory to me. By this method a complete new tread is vulcanized onto the old fabric. The expense to have a tire retreaded by this method is about one-half the price of a new tire, and gives about two-thirds the service.

Although I am a strong believer in repairing tires when they are damaged, I also think that there is a great deal of truth in the old adage, "An ounce of prevention is worth a pound of cure." Buy the very best quality tires that you can from a reliable maker who puts his name and trademark on his product, keep them properly inflated, drive carefully, keep the wheels properly aligned and you will get many miles of service before it is necessary to see the repairman.

BEN H. PARKER, Oklahoma City, Okla.

CARING FOR TIRES

THE following few simple rules have been responsible for giving an average of 6,000 miles to a shoe on a medium weight 30-horsepower car fitted with 34 by 3½-inch tires, but the procedure is the same on any machine having all four tires of the same size, and will give equally good results, conditioned upon the faithfulness with which the rules themselves are observed.

Always put a new shoe on the rear. That's advice of the sort that's not apt to be followed where two tires have to be pumped by hand, so get a power pump or an air bottle. A pump also makes it easy to follow that stock piece of advice that is invariably handed out right and left, whenever tires are mentioned—keep your tires properly inflated. The motorist who isn't sufficiently interested to keep the pressure up when the motor will do the work for him isn't looking for advice as to how to get the greatest mileage out of his tires. But just because you have a power pump don't abuse it's willingness—don't pump your tires too hard. Keep them 10 to 15 pounds lower in summer than in winter, and as a shoe gets old maintain the pressure at a lower figure than when new. Don't

be surprised when you pump a tire up to the maximum permissible pressure in the cool of the evening or night, if it blows out after a hard ride the next day, particularly if the next day be a summer scorcher.

After a shoe has run 3,000 to 3,500 miles on the rear, transfer it to the front, and it's a good idea if the tire is badly worn to put a reliner or other reinforcement round the tube when making the transfer. Before applying the old shoe to a front wheel, examine its interior very carefully for breaks and rough spots. It will be nothing unusual to find that it has been cut through in one or two places, though the openings will be small. Mend these breaks by vulcanizing two or three piles of rubber-coated fabric, cut bias and placed diagonally across the opening inside, and at the same time cleaning out the cut in the tread and vulcanizing it.

Buy a small vulcanizer—*and use it.* An hour or so once a week will be sufficient to vulcanize the bad cuts in the tread that go through to the fabric—even the most innocent-appearing wounds often do that, and if neglected they cause the "sand blisters" that soon appear anywhere from two or three to ten or twlve inches away. This means that sand and water have been forced that distance between the fabric and the rubber, stripping the latter from its foundation. The fabric is the life of the tire, but its existence will be greatly shortened if deprived of the protection afforded by the rubber tread. Keeping all cuts sealed up by vulcanizing new rubber in them as fast as they appear maintains a waterproof covering over the fabric. Water and the grit forced in with it is the greatest enemy of the canvas. Use plenty of soapstone or talc when inserting a tube and inflate the latter slightly before inserting in the shoe—just enough so that it rounds out into place without any kinks. Supplement the above by keeping all four wheels on the ground when rounding sharp corners and tires will not be half the trouble they are commonly reputed to be, while the demands on the pocketbook will be considerably eased. Speed is an important influence in tire wear, of course, but the record mentioned has been made at constant average speeds of 25 to 30 miles an hour, which is as fast as car can be run economically; likewise as fast as any sensible motorist should drive.

RICHARD WRIGHT, New York.

Pressure, Comfort and Economy

The relation of tire pressure to ease of riding and tire life is not necessarily a matter of the car driver's love of luxury or the condition of his pocketbook. In stating what may

seem to be excessive tire pressures to which we should adhere, the tire manufacturers have taken into consideration the tendency of car owners to overload their tires by the use of heavier bodies, quantities of luggage and attachments that add considerably to the total weight to be carried. The effect of tire inflation on a tire is not so much a matter of actual pounds pressure that it contains, regardless of its load, as it is a question of sufficient pressure to retain the general curvature of the tire at its point of contact with the road without an attendant flattening or increase in diameter greater than nine or ten per cent.

Above a certain inflation pressure the value of such pressure becomes lost and the action of the tire partakes more of the nature of a solid tire. The smaller the tire in relation to the load carried, the greater must be the pressure per square inch of cross section, and therefore the less resilient will become the action of that tire on a rough road.

It is generally admitted by tire manufacturers that the arbitrary figure of twenty pounds pressure for each inch of cross section is purposely made some ten or fifteen per cent. higher than is absolutely necessary in order to care for probable overloading, infrequent testing and variations in air gauges. *But it must be borne in mind that this arbitrary figure applies only when the tire is loaded with its normal weight.*

I have found that when a tire is loaded to one-half a pound for each cubic inch of air "volume," without passengers, it is carrying a load for which it is well adapted, and in the light of average practice this represents slight "overtiring." On this basis, however, a 34 x 4-inch tire would have a capacity without passengers, of 2,684 pounds, and under these conditions I would keep that tire pumped to approximately its normal pressure of 80 pounds (although I might be tempted to take advantage of the ten to fifteen per cent. leeway allowed if I knew that my gauge was accurate). If I find that this pressure results in hard riding I will put on the oversize or 35 x 4½-inch tires rather than reduce the pressure in my 4-inch tires. On this same basis of figuring, 4½-inch tires should be pumped to 90 pounds, when they have a normal load of 3,510 pounds, but they are loaded to approximately but 26/34ths of their normal capacity and therefore they need be pumped to but this fraction of 90 pounds, or approximately 69 pounds. With the larger tire, therefore, a pressure of 69 pounds per square inch will give sufficient inflation to prevent the undue flattening of the tire at its point of contact with the ground, and yet will give considerably greater comfort in riding. By continuing this system of proportion on the basis

of 20 pounds pressure for each inch of cross sections, when the tire is loaded to one-half pound for each cubic inch of volume, we can determine the proper size and pressure for tires of any weight car. HAROLD W. SLAUSON, New York.

Depends on the Personal Factor

In order to get the maximum service from the tires care should be taken to see that all four wheels are parallel and revolve in planes parallel to the line of the car's motion. This will usually not be the case if the axles are not exactly parallel. On chain-driven cars it sometimes happens that the distance rods on the rear axle are not adjusted equally.

It occasionally happens that the clips over the springs become loosened and the axle may shift slightly along the springs.

Another cause of abnormal wear on tires is a "gripping" clutch or brakes. If these are not arranged to engage gradually the tires will be robbed of considerable mileage. Perhaps it is unnecessary to say that lubricating oil has a detrimental effect on rubber.

Tire inflation is a subject on which considerable has been said. In a few words, a tire should pumped up so that it will hold its shape under the particular load it is to carry, but not enough so that it will transmit every small shock to the axle. Tables furnished by the tire makers are a good guide, but the weight carried should be taken into account. In order to hold their shape properly a set of small tires on a particular car may have to be pumped up until they are quite uncomfortable to ride on, while a larger set will keep their shape at a much lower pressure and act as a much better shock-absorbing medium. Tires should be pumped up to the proper point, but more than that they should be kept pumped up. Carbon dioxide gas from the exhaust gases or tire tanks quickly forces its way through the walls of the inner tube. If power pumps are used care should be taken to see that they do not pump oil into the tire along with the air. It is also well to keep the rims as free from rust as possible. Whenever a tire is removed from the rim inspect the latter for rust. If any is found it should be removed with a piece of emery cloth and the rim shellaced. The tires themselves should be inspected frequently when in use. Cuts in the outer casings should be filled with "mastic" as soon as noticed and the casings should be kept free from mud and foreign matter.

Aside from the above points it is the opinion of the writer that the life of tires is dependent chiefly on the personal factor —the driver. It is possible for a careful driver to run a properly designed car equipped with proper tires for several

thousand miles without trouble, while another driver would use up several sets. The first would not "hit 'er up" to mile-a-minute speed without slowing up again before the tires had a chance to overheat, while the latter would disdain to turn aside from stones in the road and will take all the bumps at high speed. J. Twitchell Lansing, Worcester, Mass.

PATCHING THE WAYSIDE BLOWOUT

IN the roadside repair of a blowout there are, theoretically, two features to be considered; namely, repair of the tube and repair of the case. Practically, however, it resolves itself into repair of the case alone, as, if the motorist has no spare tube and has a really bad blowout, he might as well go in on the rim. The materials which one should have are: an inside blowout patch of frictioned canvas, made to hook over the clinch of the tire on both sides, and an outside patch of either leather with steel studs, or fabric. Those that lace on are best as a temporary repair, since they are more easily put on and will hold quite long enough for all practical purposes. The procedure is as follows: The case having been removed, the inside is cleaned with gasoline in the neighborhood of the blowout and the canvas interior roughened with emery-paper or fine sandpaper. A coat of rubber cement is applied to the inside of the case, and to that surface is applied patch which comes in contact with it. After five minutes a second coat is applied, allowed to become "tacky" and the patch is fitted in, the case meanwhile being held to its natural shape so as to eliminate the bulge caused by the blowout. The patch is now "ironed" in with the fingers or the round head of some tool, and allowed to dry for a few minutes. The new tube is sprinkled with talc or graphite introduced with due care not to dislodge the patch and the tire is fitted to the rim, making sure that the side of the patch as in such position as to be held by the hooks of the rim, if it be a clincher. The tire is now pumped to about one-fourth of its normal pressure and the outside patch carefully fitted and laced on quite firmly. The tire is then brought to its normal air pressure, the job inspected, and if the outer patch is not too tight this blowout will give no further trouble for many miles.

However, being provided with a blowout and little else, much may still be done in the way of riding to town on four pneumatic tires. The same repair materials are utilized, but they must be made on the spot and of whatever happens to be handy. The inside patch may be "faked" from a piece of

canvas, a piece of an overcoat (if not too heavy), a square of leather or even a section of a heavy inner tube. It may be made to hold some miles without cement, if put in carefully. A piece of leather or a section of a wornout casing will do very well for the outer patch; it should be laced on even more carefully than the regular outside patch. And, finally, lacking everything else, the hole in the case may be stopped with anything that will cover it and the place of the tube taken by a few handfuls of oats or hay.

If no new tube is carried and the rent is not too large it may be patched so as to hold a few miles. The cementless patches, so convenient for punctures, are almost useless here. A strong rubber patch and several coats of cement are required. A section of an old tube is really the best patch, but probably will not be in the car if no provision at all has been made for the ever-possible blowout.

The methods and materials outlined above are not new, nor are they the only ways and means of accomplishing our purpose; but they have given sufficient satisfaction time and again, and are neither complicated, costly nor unduly time-consuming. DR. C. D. ENFIELD, Jefferson, Ia.

Utilizing Old Tires

This is not for the motorist who is satisfied with the attention his car receives at the average garage, or at the hands of most chauffeurs, but for the one who enjoys keeping his car up to the concert pitch at all times. A blowout can only be temporarily repaired with a blowout patch and a tire sleeve, and it takes no more time to repair it permanently. Most any motorist has an old casing on hand. If he will cut out around the bead on each side of the case and cut across the tread deep enough to go through the tread and binder (or first layer of canvas) he can, by placing one end in a vise, start the other end and strip completely all rubber and binder from the case, leaving an endless three or four-ply canvas liner which, when rolled up, requires very little room in the machine. When the blowout occurs insert a good blowout patch and then the liner, which will not require to be cemented. Dust the inside of the liner with graphite; it is far better than soapstone, and the insertion of a floating flap will completely cover the edges of a new liner. This gives a permanent repair which will outlast the tread many times. The time required for the whole operation is less than it takes to inflate the tire. As soon as opportunity presents itself pack a few layers of gum in the broken tread and clamp on the vulcanizer for thirty minutes—and the case is better than

if a new section had been put in. A few dollars invested in a vulcanizer and a few minutes' attention now and then, given to the tires, are money and time well spent.

Mrs. C. B. Hainson, Belleville, Ill.

A Use for Old Tires

If, instead of disposing of all his old shoes to the junkman as fast as they wear out, the motorist will reserve one that is fairly good, and cut into sections of various lengths with a hacksaw, he will be most admirably equipped to answer this query by making a good repair of the blowout right then and there. He will not have to worry about driving home on a "flat," giving up for a new shoe, or struggling to make his credit good with a garageman who never heard of him before he stranded in that particular neck of the woods. It must indeed be a very wreck of a blowout that cannot be made good with one of these emergency shoes. I have driven a tire through which the whole hand could be inserted, and not simply "home," but a matter of 200 miles or more, with the aid of this cheap and extremely effective expedient. And the strange part of it is that that shoe did not give up the ghost even then; the home-made patch shifted and let the tube "bubble" out of the hole, without injuring it. Rather than take chances of a repetition, I discarded the shoe, but I know there's two or three hundred miles of wear in it yet.

To make these emergency blowout repairs, I took an old worn-out casing and cut the best part of it into five pieces of different lengths with a hacksaw, cutting at a decided angle so as to bevel the ends. The beads were then trimmed off, the bevel and other parts smoothed up as much as possible, and the repair was ready for any emergency. The shortest one is six inches and the longest eighteen inches. This will make good a shoe that has blown itself clean in half, except the beads, while even the shortest one will take care of a very fair-sized hole. The various-sized patches are not really necessary—the one long one will meet all requirements and meet them better—but it makes replacement of the shoe on the rim somewhat difficult unless equipped with one of those new tools that make it easy to squeeze the shoe together so that the Q.D. rings can be put in place. This is the chief expedient that I should recommend to the man who wants to be ready for a bad blowout at a time when a spare is not at hand and not readily obtainable—buy one of those tools. The long patch costs nothing and should always be on the car. It has any and every form of patent blowout patch ever put on the market backed completely off the boards; if you paid $10 for it you

couldn't buy anything better. No outside reinforcement is really necessary, even in severe cases; the eighteen-inch patch will fix anything that can be fixed at all. An outside blowing patch will keep mud out of the hole, but that's about all. It will wear out in a hundred miles and the car will bump uncomfortably as long as it lasts.

RICHARD WRIGHT, New York.

CONSERVING THE TIRES

IN view of the number of motor cars in use, it is surprising to find how much ignorance there is regarding the construction and care of tires, and the troubles to which they are liable. Many owners have fairly comprehensive ideas of the motor and parts relating to it. They can talk intelligently of magnetos, carbureters, valves, clutches, transmissions, etc., and can frequently locate trouble without difficulty. When it comes to tires, however, they are lost, and all they know is a "blow-out" and, even then, to be exact, they do not know that. Literally speakin, they are correct, but technically they are wrong, when a casing, shoe or tire, whatever you wish to name it, gives way from any cause, the inner tube containing air at a pressure of from fifty to ninety or more pounds per square inch naturally blows out. But probably not one case in a hundred is a genuine blow-out caused by defective construction, but is the result of a bruise or cut.

A casing, as we shall call it, is built up of from four to seven plies of rubber-covered fabric shaped up around hard rubber rings forming the beads or clinches, covered with a coating of rubber over the entire body to protect the fabric, and over all the thick tread wrapped or molded on. The casing is, of course, shaped up on a suitable form or mold and is then vulcanized in a steam box or drum (generally called a kettle) for a certain length of time at a certain pressure.

These factors vary with different tire makers according to the compounding followed. After they are once determined by extended experiment, it follows that the same compound subjected to the same treatment must naturally produce uniform results. In building up a casing, one ply is put on at a time, and each ply laid on in absolute contact, one with the other. Unfortunately, it sometimes occurs that at one place there will not be this absolute contact. When this casing is put in service the separation will permit an internal chafing that first pulverizes the rubber coating. Then the plies of fabric chafe one on the other, and they in turn pulverize. After running a few hundred miles this weak spot blows out,

and the tire owner can then truthfully claim a "blow-out." Inspection of the break will show plainly the separation of fabric, and the fine dust, looking somewhat like dirty flour, thickens the genuine blow-out.

The point that puzzles most owners is a fabric break on the inside of the casing, and no sign of a cut on the tread. As an illustration of the manner in which this may be caused, it is only necessary to watch some drivers negotiate a railroad crossing at grade, on a smooth, level road. Many of them, seeing that the crossing is clear, slow down little, if any. The front wheels lift as they strike the near rail, and the momentum is such that they generally drop full on the far rail when they do come down. The rail does not leave the sign of a mark on the tread; but sometime later, maybe a few hours, sometimes several days or even a week, one or both the front tires blow out, and the motorist unburdens himself of a few remarks regarding "punk" tires.

Now, what really happened was that when the tires struck that far rail they were pressed in to such an extent that a small fabric break started. This gradually increased until it had opened up sufficiently to allow the tube to force itself in. As the wheel revolved, the break closed down and pinched the tube, which, of course, blew out. The sudden expansion of the air then forced through the plies of fabric not already broken, and the casing is in need of a "section." It is probable in such a case that, the tread being too heavy to permit the blow-out to pass through, the fabric will be ripped clear down to the side walls, as the point of least resistance, and the gap will make the tire look very bad. If the owner knew as much about tires as he should, he would then make no claim for a defective tire. He would see the result, and, by thinking over his handling of the tire, would recall the cause of the trouble. Any obstacle large enough to give the tire a shock if struck, and not having sharp edges or corners, will cause these fabric breaks and yet not mark the tread.

The fabric, in making motor-car tires, is cut on the bias. The ladies will all understand this, but for the benefit of the men it must be explained that it means that the fabric is cut diagonally or at an angle with the line of weave. The entire roll of fabric is cut up in this manner into strips of proper width for the particular cross section of casing desired. When built up into the completed casing, the lines of weave run diagonally across, and a fabric break caused by a bruise or blow, shows as running at an angle instead of straight across or parallel with the sides. The principal reason for this method of cutting the fabric is that it leaves but little full-

ness in shaping up around or along the bead. The tire being from six to ten or more inches smaller in diameter on the rim than on the tread, there would be considerable wrinkling if the fabric was laid on with the weave; and, even if this could be done, a fabric break, once started, would continue around the entire circumference.

The one thing vital in securing maximum tire service is proper inflation. Insufficient inflation is responsible for ninety per cent of tire trouble. Rim cuts, fabric breaking, separation of fabric inside and of rubber cover outside, are in a great measure due to this fault. When advised regarding inflation many owners bring up the old cry about getting out in hot weather on a hot road and having a blow-out because the heat expands the air in the tire to such an extent as to cause damage. If the casing has had proper attention from the time it was first used, and the fabric is intact, it is almost impossible for the air to expand sufficiently to cause damage. At the same time it is a simple matter to test the pressure from time to time and if found to be going up, to reduce it by letting a little air out of the valve. A pressure gauge applied to all tires in service would show a small percentage of cases where there was necessity of reducing the pressure that it need not be considered.

The point on which the question of inflation really hinges is that of speed. If a casing of a certain section, say four inches, which was designed for inflation at eighty pounds per square inch, was never driven at a greater speed than fifteen miles per hour a pressure of fifty pounds might be ample. An obstacle struck by a tire traveling at that speed would be passed over easily and have no effect upon it. Now, assuming that the pressure of fifty pounds is retained and that the tire strikes the same obstacle when going at a rate of thirty miles per hour, the result will probably be a serious injury to the fabric of the tire, as the shock will be four times as great as at fifteen miles per hour. If the speed be increased to forty-five miles per hour, the shock will be nine times as great. In other words, the force of blow or shock increases directly as the square of the speed.

Many owners state that they do not understand how it is possible to force a casing in, so as to cause a fabric break. With proper inflation this is hardly possible without a great shock, yet if they will consider the matter a moment they will see that it is the fundamental principle of the pneumatic tire to yield to the inequalities of the road. There is no doubt that a highly inflated tire rides harder, but as tire expense is one of the banes of motoring, it is better to sacrifice a little

comfort and make the springs assume a little more duty, than to have continual expense, to say nothing of trouble on the road.

There are other causes of tire trouble, however, and these are generally due to the driver. In starting up rapidly there is likely to be considerably slip, and this will wear a tire down quickly. Sudden and frequent application of brakes are especially hard on tires, not only from the sliding of the car after the rear wheels stop, but from the skidding or sideway sliding due to sudden braking. The rounding of corners or curves at high speed causes this same skidding movement, and at the same time creates an undue strain on the whole casing, particularly on the side walls and beads. Turning a corner at high speed will sometimes twist the casing to such an extent as to lift the beads out from under the rim, with the result that the whole casing blows off the wheel, running the inner tube. When a casing once blows off the rim it is probable that the beads are so badly stretched as to preclude further service. Even if the casing stays on the rim, the twisting will lift the beads slightly, and the tube will force under one side or the other. When the car straightens out on its course, the bead settles down and pinches the tube and down goes the tire. While inner tubes are not as costly as casings, yet a few ruined tubes will quickly run up the tire expense.

When a tire goes down, due to a puncture or any other cause, the only logical course to follow is to change the tube immediately. A casing run deflated, even for a few hundred yards, is likely to be ruined beyond hope of repair. The fabric will separate all around inside, and the rim will chafe through the sides. While it is most exasperating to be compelled to change a tire, particularly when one is in a hurry, it is the only course to follow if it is desired ever to use the casing again.

There is one trouble, and a very common one, that arises from having the wheels out of alignment. This is often noticeable on front wheels, and the result is the wearing off of the tread in a few hundred miles. The reason for this is that, in addition to the wear due to the revolution of the wheels, there is a drag or scraping owing to the wheels toeing in or out. To detect this, it is only necessary to stretch a cord from the back edge of the rear wheel to the front edge of the front wheel. If the cord fails to touch the back edge of the front wheel when drawn taut, it shows that the wheel points outward. If it does not touch the front edge of the rear wheel then the front wheel points in. In either case the effect is practically the same, and the tread is likely to wear down on

five or six hundred miles. It is not often that this trouble is found in rear wheels.

To sum it all up, it is only necessary to state that the motor-car tire of to-day is the result of years of experiment and logical study, coupled with vigilant mechanical supervision and inspection. A little reciprocity from the motoring public would result in mutual satisfaction, and the elimination of much of the friction that occasionally develops. S. D. Just.

PROPER CARE OF TIRES IN WINTER

Republic on the Care of Tires in Winter

THERE is nothing the motorist should practice more than the conservation of motor car equipment. Tires, as a rule, receive less attention and are called upon to go further and do more than any other part of the car equipment, and we therefore feel and hope that the motorist may derive something beneficial from a few suggestions "picked up" in our years of experience in the manufacture of tires.

On paved or city streets the motrist in winter months has snow, sleet and rain to contend with, and as there is great danger in skidding, chains should be properly applied and used. This requires much care, as improper application is not only harmful to the tire but the chain as well. It is not necessary on dry roads to use them, as a good reliable non-skid tire prevents side slipping or skidding. Avoid car tracks, as they allow the rear tires to slide or spin while stopping or starting and there is also great danger of skidding in turning out of them.

Frozen country roads cause a great deal of trouble, causing cuts and bruises. Long tread cuts are the ususal results of driving through mud roads caused by the spinning of the rear wheels over sharp stones, and we again suggest the use of chains under such conditions.

Once or twice each month a reliable vulcanizer should be used and all necessary repairs made. Neglected cuts allow gravel and water to enter and loosen the tread, and if small matters are not cared for promptly and properly they soon become large ones. Brakes should be inspected frequently. Do not apply them suddenly, unless, of course, to prevent accident; this as well as spinning the wheels when starting is very bad practice and should be avoided. Under-inflation has been the most direct cause of tire trouble and is uncalled for when one considers that almost every city block

and every small town has either a tire repair shop, garage or accessory store which is equipped to furnish air absolutely free of charge. An underinflated tire will roll over the stones instead of kicking them aside and cause a bruise or break in the tire which later results in a blowout. Rim cuts, separation of the plies of fabric and other trouble are to be found if this is not watched closely. Driving on a flat tire results in the troubles mentioned above and, if not equipped with a spare casing, run on the rim. Front wheels should be examined and kept in proper alignment at all times, as this will cause both rubber and fabric to wear through in a very short time.

Cars which are stored for the winter should not be allowed to stand on the tires. This is very hard on both casings and tubes and renders them unfit for service when the car is again put into service. We would recommend in this case that the car be jacked up and set on blocks or "horses" and about one-half the required air pressure left in the tires. Before the car is put into service, demount the tires and have them carefully examined; all rust should be removed from the rims and graphite applied. This method, in our estimation, and after several tests, has proven most satisfactory at the least expense. There are several suggestions on the subject, such as demounting the tires and wrapping separately in paper cloth or burlap and should be stored in a dry dark room; however, as stated above, we have found the first mentioned to give just as good, if not better results, and will enable the motorist to realize maximum service at minimum cost.—Republic Motor Co.

What Michelin Has to Say

First of all, many tire manufacturers will tell you because of some particular pattern of non-skid tread employed that chains are not necessary in winter, but we do not do this, because we believe that chains are absolutely necessary under certain conditions. There is a right way and a wrong way, however, to use chains.

For example, chains should be used only when necessary for safety. Some motorists keep their chains on their tires for weeks at a time, using them on hard, dry roads—such misuse subjects the chains to unnecessary wear and also injures the tires greatly, as the cross links of the chains will be forced into the rubber owing to the hard unyielding surface of the road when dry.

A motorist should always be very careful to adjust his

chains with tension just sufficient to allow them to creep slightly, otherwise the cross links will wear through the rubber of the tread very quickly. Care should also be taken always to fit the chains with the same side toward the casings. When chains are in use friction with the road wears off the smooth rounded surface of the cross links, leaving rough edges. Now, if the motorist when again fitting his chain does not take care to fit them with the same side toward the casings the sharp edges of the cross links will cut through the rubber very quickly.

Another precaution; many tires are ruined from rough usage by driving in deep frozen ruts. No tire will stand abuse of this sort, because the rough sides of a frozen run will very quickly grind and chafe through the side wall of any tire. Of course, there are times when it is necessary to run in ruts for a short distance, but nearly always ruts can be avoided by driving in second speed over on the side of the road, or even on the wrong side of the road when passing deeply rutted spots.

When a motorist lays up his car for the winter he should give special care and attention to the manner in which his tires are stored while out of commission.

It is highly advisable to remove tires from the rims and jack up the wheels of the car. There are three reasons for doing this—it relieves the tires of the weight of the car; it gives the owner an opportunity to clean his rims, which is very important as the accumulation of rust on a rim will work severe injury to both casing and the tube; the third and most important reason for removing tires from the rims is that they may be removed to a place of storage under suitable conditions.

When a rim becomes rusty it becomes very rough, and if this rust comes in contact with the tube it will very soon cut through the tube in places, in all probability ruining it beyond repair. Furthermore, the rust on the edges of the rims will chafe through the rubber on the side walls of the casing, leaving the fabric exposed to further injury from the rust.

When a fabric of any tire is in constant contact with a rusty rim the rust will eat through the fabric plys until the tire gives out just above the bead.

The removal of tires during winter storage gives the owner an excellent opportunity to clean his rims thoroughly, which should be done with emery paper, then a coat of black varnish should be applied and the motorist will

be assured that his rims are in good condition for the next season's usage and will not work any injury to the tires.

It might be added further that there are three elements of danger to tires when in storage; namely, heat, light and moisture. To guard against dangers from these three sources it is only necessary to store the tires in a comparatively cool and thoroughly dry place and to cover them in such a way that the light will not strike them. Failure to protect casings and tubes from these three elements will most certainly result in deterioration to both casings and tubes. This means an unnecessary bill of expense for the owner, and what is more important, it involves the waste of two materials—rubber and fabric, the conservation of which is most necessary at this time.

Whether tires are left on the car during the winter, or are removed for storage, they should be kept inflated to a sufficient degree to retain their normal round shape.—Michelin Tire Co.

MAKING THE TIRE CHANGE EASIER

THOSE whose cars are fitted with demountable rims, or wheels, will usually find that, in the long run, they change tires at home in the garage about three times as often as they do on the road. Sometimes a tire goes flat during the night; again a slow leak develops. At other times, one changes a tire on the road and puts the new spare on the wheel. Wishing to keep the good spare tire for emergency use, the old tire is fixed at home, and then the old tire is replaced.

On account of the number of tire changes, made in my home garage, I have fitted it up with an extra tire pump, and a complete set of tire tools. Now the tools in the car do not have to be unpacked and repacked every time I make a tire change at home. I also have a good, quick-acting jack for garage use, and a set of larger and heavier tire tools than I care to load on the car. These heavy tools are especially useful for putting new tires on the rims.

Instead of jacking up the car in the usual way, I have strengthened the roof of the garage with an extra beam. From this beam I have suspended a block and tackle arrangement and have a set of special hooks so that I can lift up either the front or rear of the car, as may be desired, by simply turning the convenient crank handle of the little

winch which is fastened to the side wall of the garage. This hoist arrangement would be too expensive to justify its use only for tire changing. But, since it is so convenient for lifting the car for all sorts of repairs and adjustments, I have certainly found it a worth while addition to my garage equipment.

MURRAY FAHNESTOCK, Pittsburgh, Pa.

Many Inventions

The majority of car jacks are provided with short detachable wooden handles making it necessary for the driver to kneel when placing the device in position under the car axle. If the short handle is discarded and a two foot section of broom handle is tapered to fit into the handle socket a much more convenient manner of placing the jack without soiling of hats or trousers is provided.

On soft or sandy ground the small base of a jack does not provide a very stable foundation and the result is usually when the wheel is jacked up to the required height, the lifting tool tips over and down goes the axle. I find that by removing one of the small floor boards in the front of the car and placing this on the ground for a base the car can be jacked up quickly and will stay in this position without toppling down while the tire is being removed and replaced.

While it is necessary to work the jack handle to lift the axle, it is not necessary to jack it down again. When the tire work is over give the car a slight push and lift the jack over. No possible harm is done and it saves a minute or more of time.

A while back when I had accustomed myself to the use of the small jack and narrow tire irons, which are made so with the probable intent of saving steel, I watched a one-armed man change a clincher tire. He removed the old tire and put on a new casing in one half the time in which I could do it. His method was to put the tube inside of the casing, place both beads over the rim and with the aid of two pieces of broken spring about twenty inches long and two and one-half or three inches wide, he placed one piece between the tire beads and wheel rim, turned the wheel until the tool was near the ground, placed his foot on the tool, and with his one hand he inserted the other tool in a like manner and pried the tire over easily. The advantage of prying over both beads at the one time, other than that of saving considerable time is that the inner edges of the beads

close up and keep the inner tube in place, thus eliminating the danger of pinching the tube between the bead and rim or between the tire tool and rim. I have always, since then, used two pieces of spring leaves for tire work and find that the width of these tools affords a comfortable hand hold and they are of the best grade of tempered steel that is not easily bent or broken.

An ordinary "C" clamp, apart from other usefulness, is an excellent tool for loosening rim rusted tires. Place it over the tire as you would a caliper and take up on the screw. Rusted rims, however, are a nuisance that should not be tolerated for the tires and tubes are both damaged to some extent by this condition.

It is a very easy matter to apply a coat of ordinary stove polish to the rims when tires are changed. This polish contains a considerable amount of graphite which in addition to protecting the rims makes the work of removal and replacement of tires easier, the stove polish being a sort of waterproof lubricant.

G. A. Luers, Washington, D. C.

CHAPTER XII

COMMON AND UNCOMMON ROAD REPAIRS

CLEVER EMERGENCY REPAIRS

PERHAPS the most important emergency repair I ever made made on the open road in order safely to operate my car, was the temporary cobbling together of the jackshaft drive on a Metz, which employs a friction drive through two chains to the rear wheels.

It occurred last November, and I had left Evansville, Ind., at noon, expecting to make St. Louis, Mo., early the next morning, a distance of 245 miles. About 10 o'clock that night I reached the oil field section of Illinois, a very hilly country. At this point one of the drive chains broke and was lost overboard. With the aid of an oil lamp from the side of the car I finally found the chain, only to discover that there were no repair links in the tool box. However, I managed a temporary repair, using as rivet a nail filched from a small bridge nearby. This job served well enough until I struck several miles of low river bottom road, which was extremely heavy from a fine rain that had been falling since early evening.

Just after passing over a creek on a loose plank bridge, the car came to a halt, the engine continuing to run; the chain had broken again and dropped off somewhere along the road. This allowed the power to escape through the idle side of the jackshaft, upon which the differential is located.

I spent more than an hour searching for the chain with the help of the oil side lamp, but vainly—it was lost forever. Probably it had slipped through the planks of the bridge and was at the bottom of the creek.

I was now seven miles from the small village of Clay City, where help was improbable, and thirty-one miles from Flora, a town of some fifteen hundred people. Decidedly it was "up to me." I started the engine to see if one chain would not pull the car; it would not. Then I noticed that the sprocket wheel on the jackshaft revolved when the friction drive was applied and it struck me that if I could anchor this wheel and keep it from going round I might get somewhere.

I "borrowed" about ten feet of wire from a neighboring farmer's fence and wired the sprocket wheel to the frame in such a way that it could not move. Then I applied the friction drive and discovered to my delight that the single chain was able to move the car, though at a pace comparable to a snail's progress.

Eventually I reached the town of Flora and secured a new chain, which came on by a morning train, and I reached St. Louis just twelve hours late.

GOOD LUCK, Granite City, Ill.

Repairing a Broken Spring

Speaking of emergency repairs on the open road, when it would have been unsafe to operate the car had I been unable to remedy the trouble, I recall a hurried trip to Detroit. I was driving a Franklin machine, and for the benefit of those unfamiliar with its construction we will note that same employs the Hotchkiss drive, all driving stress being borne by the main leaves of the rear springs.

When about 100 miles from my destination and within ten miles of the nearest garage, the main leaf of the lower half of the right rear spring broke half way between the axle and the end of the spring, leaving nothing but the small spring leaf clip to support the drive on that side.

By forethought I was prepared for such an accident, through having provided myself with two pieces of flat steel 2 inches wide by ¼ inch thick, having holes bored in each end through which I inserted cap screws of sufficient length to firmly clamp both pieces directly over the break in the spring. By virtue of this makeshift I was able to proceed with the journey after a delay of only fifteen minutes, and continued to use the car for a period of ten days before being able to secure a new leaf from the factory, our service branch having none in stock.

Circumstances alter cases, and in view of the fact that the trip in question was of vast importance to my employer and any great delay a serious matter to him, and due to the fact that it would have been absolutely foolhardy to attempt the remainder of the journey with the spring in a broken condition, it seems to me that the repair in question was a most serviceable one and it might not be out of order to state that I have since had occasion to make the same repair on a Locomobile.

J. R. B., Battle Creek, Mich.

Improving a Bearing

One has many funny and interesting experiences in fifteen years of automobile driving, and some of the makeshifts and

temporary repairs that I have made or seen others make in the early days of motordom would look and sound like fairy tales to most of our new drivers.

I remember, along about 1904, starting for home one summer day. When I was about twenty-five miles on my way I heard a terrific pound, coming from the region of my crank case. Now the crank case of this particular car was located back of the front seat, and the engine was of the two-cylinder type, a truly wonderful and fearfully made construction as I had learned to my sorrow.

I recognized the knock as an old friend—or enemy—and had no trouble in diagnosing the case as a pair of burned out babbits, nothing new by the way, and a trouble for which I was usually prepared by carrying an extra set of bearings.

In this instance I found that the extra parts were lacking and I set about for some means of making a temporary repair that would speed me on my homeward way.

I found that the original babbits were ground to small fragments and were of no further use, so I searched my repair case and tool box for something that might be used for a bearing surface, finally settling on a long, thin, flat strip of copper. This I wound as tightly as possible around the bearing surface of the crank shaft, tightened up the bearings, applied a liberal dose of lubricating oil and joyfully drove the twenty-five miles home without further trouble.

On another occasion a few years later while driving a four-cylinder car, it suddenly developed a terrific bump with every turn of the rear axle. After a little thought and experimenting I jacked up one rear wheel and found on turning over the said wheel that a piece of steel had broken off from the big bevel gear and had become imbedded in the teeth of the gears. I opened the oil hole in the differential case, turned the wheel over till I found the piece of steel, drove it out from between the teeth with a hammer and cold chisel, picked out the broken piece and drove on my way rejoicing.

To the best of my memory I have never been hauled home but twice, once with a broken crank shaft absolutely beyond repair, and on another occasion I had a steering gear give way while driving at a fair rate of speed, with the result that my car collided with a hedge, smashing radiator, wheels and axles.

I have repaired a broken spring with a board and some wire; have used flaxseed in a leaky radiator to bring me home; once upon a time I burned the platinum off the contact points of my old-fashioned breaker and made a new one with the tip of a steel nail—the spark was not perfect, but she managed to hit intermittently and I got home in good shape.

One car which I owned had a timer of the old-fashioned type

and it was a daily occurrence for it to slip its timing and have to be reset. This I did so frequently that it became a very small job to do quickly and easily.

It has always been my contention that the owner or driver should be able to detect and make small minor repairs such as valve trouble, carbureter or spark plug difficulties, etc., and the man who lacks this simple knowledge has no one to blame but himself when he gets "hung up" forty miles from home, with some small trouble that he cannot diagnose.

J. G. HOFFMAN, Kewanee, Ill.

A Broken Torsion Rod

The car I drive was made in those days when close attention to details of ultimate safety were rather lax, having been designed with the torsion rod before and on a level with the front axle. I was traveling over some rough road when something struck the torsion rod, breaking and bending it. To repair the damage equipped machine shop to handle, with a tedious tow-in as addi- presented quite a problem, as it looked like a case for a well tional trouble. I succeeded in getting hold of some necessary tools and supplies and started to work on a repair. I cut the bent section of the rod out on both ends of the break and succeeded in straightening it. I obtained a piece of one-inch water pipe, the inside diameter of which was approximately the thickness of the torsion rod. I removed one end of the torsion rod, slipped the pipe on, which had previously been cut to fit between the points where the rod curved down beneath the springs, then inserted the straightened section of the rod, then added the other end and replaced the entire assembly. Three quarter-inch holes were then drilled, one to each section of the rod. Three twenty-penny nails were next cut and riveted in to hold the assembly together. As an extra measure of safety several lengths of some heavy wire were run between the two spindles and twisted tight with a screwdriver. The repair was sufficiently successful to permit me to get home although the driving was of necessity rather slow.

My car is no exception to those that, having seen better days, are particularly liable to give trouble, so I was not surprised when a sudden aggravated case of overheating developed. I investigated the motor and found the water pump shaft to be broken. With the usual facilities that are available for roadside repairs I set to work. The pump was removed, and with a 3-16 inch flat file I filed slots in both ends of the broken shaft directly opposite each other and to a depth of a quarter of an inch. This proved to be rather hard work, but the hardness of the steel made possible the success of the job. I then cut off the pointed

handle end of the file and made a piece 3-16 thick and the length of the diameter of the shaft. The pump was then replaced, with the piece of file placed in the slots. Tape was next wrapped around the whole assembly, with broken hacksaw blades worked in between the various layers. In addition it was well wrapped with steel wire, and finally two hose clamps were placed on. The whole job was assembled with the idea of permitting a universal joint-like action to take place at the repair, as it was impossible to keep the shaft absolutely true at all times. The packing around the shaft at the pump was released as much as possible without excessive water loss to reduce the stress on the shaft at that point. I termed it a tedious job successfully completed.

R. F. S., Cumberland, Md.

Shifting Gears With a Screw-Driver

We were fifteen miles out of the last town and ten miles from supper, with the sun just setting and no other machine in sight. In preparing to go through a mud-hole I had tried to shift gears too quickly with the result that the lower end of the gear-shift lever had broken off just under the ball and socket joint, leaving the car in neutral and powerless to go on. My partner got out the book of troubles, and though it mentioned a hundred and one mishaps and how to remedy them it said nothing about a broken gear-shift lever.

Just as the sun dropped behind a nearby hill I had a sudden inspiration. I told my plan to my companion, who was at first skeptical, but then, perhaps thinking of the good supper we were missing, he said to go ahead and try it.

I first took up the floor board and then, with a wrench, loosened the nuts that held the top of the gear-box. When this plate was removed the upper part of the shifting lever lifted off with it, and thus left the whole system of sliding gear-sets exposed to view. Since the slots in which the end of the lever normally slid were narrow, it was obvious that something would need to be used to take its place and that it would have to have its own handle, since it could not possibly be fastened to the ball on the original lever. The large sized screw-driver was the very thing.

With a little poking about I found which gear-set had to be pushed, or rather pried, back to put the machine into "first" and then the one for "second" and lastly the one for "high." Placing the lower end of the screw-driver in the slot and against the desired gear-set, and the middle of the screw-driver against the edge of the gear-box, I pulled back on the handle and thus pushed the gears controlling "first" into mesh. Then while I pushed out the clutch with my foot my friend stepped on the

self-starter and we soon had the engine throbbing again. As I let the clutch in very slowly the machine crept forward on to the dry road once more. We ran on "first" until a slight down grade was reached, where, pushing out the clutch and letting the car coast, I returned the gears to neutral with the screw-driver, and then pushed those of "high" into mesh in the same way I had previously done with "first." Since the machine was coasting I went, as you noticed, from "first" straight into "high," and with the machine once more under way I removed the screw-driver and we drove into town with the mere inconvenience of flying grease from the open gear-box.

EDWIN M. C. GUYER, La Jolla, Cal.

An Emergency Spring Repair

Although today motor cars are a wonderfully developed, and it seems, almost perfected piece of mechanism, there are times when the unforeseen will occur and an emergncy road repair will be necessary. When it is considered what a function the springs of a car perform and the innumerable shocks and vibrations they absorb in every mile of travel, it is remarkable that spring breakage does not occur more frequently than it does. However, when it does happen, further travel without repair is impossible in most cases. If the mishap occurs, as it did once in my experience, while on a tour and far from a repair shop, the motorist is confronted with a problem. While spring breakage cannot be absolutely guarded against, a little foresight will solve the problem and lessen the inconvenience and annoyance.

The "little foresight" should be in the form of a piece of three by four scantling. It will be found good practice always to carry a piece about 18 inches long in the equipment of the car, because there are several uses to which it may be put in an emergency. For instance, if the ground under the car is soft or unstable when a jack is used, the scantling will serve as a solid base upon which to put the jack. When two jacks are needed for a repair, the piece of three by four will do duty admirably as a jack. It can be used as a mallet in putting on tires and there are several other uses that necessity will make obvious.

But my purpose is to show how it will solve the problem of a broken spring. If the spring be a front one, the car should be jacked up by putting the jack under the frame just to the rear of the spring shackle and raising to a height above the other side of the frame. Now put the piece of timber between the frame and axle lengthwise with the frame. It should then be lashed and fastened securely at its center to the axle at the spring saddle. This should be done in such a way that it will not alter its position, which can be accomplished by cutting nicks in the timber

and fastening with wire to the axle. Next lower the jack until the frame is level with the other side and it rests upon the improvised spring of wood. If the scantling has been previously drilled with two quarter-inch holes at either end, the matter of fastening it to the frame will be simplified, for wires can be drawn through and it can thus be lashed firmly to the frame. With this done the jack may be taken from under the frame and the motorist may proceed.

If the rear spring is broken, the method will be much the same. In some cases with three-quarter or full elliptic springs it may be found advisable to fasten the timber to the broken spring, so that it serves as a brace for it, instead of fastening to the frame. With different type springs, whether front or rear it may be necessary to vary the directions outlined above in order to accommodate the particular type.

THOMAS A. CLARK, Washington, D. C.

ROADSIDE REPAIRS

ANYONE who has driven an automobile for three or four years can readily cite instances of breakdowns far from help; and the many ingenious devices utilized to get the machine to running again in order to get home or to the nearest garage. Last night the writer had one of these experiences with his automobile, a model "Fifty-one" Overland. Out in the country twelve miles from home at 8:00 o'clock at night, with roads in terrible condition, rough, muddy and half frozen, with snow beginning to fall, and the thermometer rapidly falling, the engine suddenly stopped and refused to run. Upon careful investigation it was found that the end plate of the magneto had become loosened from the clips holding it in place and had dropped away from the magneto with the cable attached. In the center of this end plate is a carbon brush which projects against the magneto and is held in contact by a spiral spring in the bottom of the socket into which this carbon brush fits. This carbon brush is a little smaller in diameter than a common lead pencil and about three-fourth of an inch long. It was found that this had been broken off and was missing. I borrowed a piece of fence wire from a farmer and began fishing in the pan under the engine trying to find this missing piece of carbon. For a half hour or more I fished in the "mud" in the pan with such light as I could get from the oil dash lamp to aid me. I could not find the carbon. Realizing that I was up against it once more, I began cudgeling my brains to think of some plan whereby I could substitute

something for the missing piece of carbon. I thought of breaking up one of my dry batteries and whittling out a piece of carbon from the dry battery. Then I thought of another and quicker expedient. I had a short stub of lead pencil in my vest pocket, and it occurred to me that possibly the graphite or carbon of this lead pencil might serve the purpose. This pencil was a very good one, one which, on account of its good quality, I had kept by me a long time and used it down pretty short. It was a pencil that had been put out as an advertisement. The lead was medium hard. I cut off a short piece of it, whittled it down to a size that would go into the socket, and then cut away the wood on each end so that the lead would project for about a sixteenth of an inch beyond the wood. After considerable difficult I managed to insert this in the socket of the cap and piece and get it into position with one end of the graphite in contact in the socket and the other against the magneto revolving brass contact. When the clips were fastened holding the cap end plate in place the lead pencil made a beautiful contact at each end. Turning the engine over it started off immediately and ran as well as ever. I treasured the remaining half inch of the lead pencil as I expected that the small contact of the pencil which was in the magneto would wear off within a mile or so and I would have to insert another. To my surprise, the engine ran beautifully the remaining twelve miles home over rough country roads with half-frozen mud and water. The next morning I removed the lead pencil from the magneto to see what condition it was in and found that it had worn down but a very little. As figured from the distance I had run, this lead pencil would have served for a hundred miles.

V. A. CHAPMAN, Muskegon, Michigan.

Improvised Steering Gear

To operate a car with a broken sector shaft in the steering gear seems a pretty difficult problem, yet I did so once in the following manner: A bolt was removed from the flange which holds the steering-gear casing to the frame and a much longer one substituted, which I obtained from the body, it being used to hold the latter to the frame. This projected about two inches. Next I obtained a piece of wood about 1 by 4 inches by about four feet long, through which I bored a hole to receive the bolt about eighteen inches from the end. This I placed in a vertical position and screwed the nut on loosely so as not to interfere with the wooden piece swinging freely. Next I bored a hole in the upper end of the same stick and bolted (using the bolt at first removed from the steering gear flange) a sec-

ond piece loosely to the first one and long enough to reach to a convenient position from the seat. Then removing the nut at the back end of the steering link which connects the steering gear to the front knuckle I disconnected this link and bound it firmly but flexibly to the lower end of the vertical stick. By pushing the second piece away from me as I sat in the seat it is easily seen that the link was drawn toward me and the car steered to the left, and vice versa I was able to run at a fair speed, and did so for a good many miles, reaching home with no further trouble.

A cuff seems rather a poor substitute for a cylinder, yet I once made this substitution with quite satisfactory results On a four-cylinder air-cooler I once found myself up against the proposition of staying out all night when it was bitter cold or running my engine with one cylinder broken off just above the flange. The real problem lay in managing the loose parts which would fly around with the rotation of the shaft, and in preventing the loss of oil from the crank-case splash reservoir. I solved the former by removing the connection rod-bearing cap and the piping to that cylinder, and putting the useless parts, namely, cylinder (upper part which was broken off) and piston rod, thus freed, in the tonneau and effectively prevented the loss of the precious lubricant by bolting my cuff under the cylinder flange, thus preventing the oil splashing out. The other three cylinders ran all right when I remembered to plug the open end of the intake manifold with waste. E. P. DP., Wilmington, Del.

A Broken Rear Axle

My most interesting experience with a breakdown was while on a run one Sunday from Washington to Baltimore. When going up a small hill, about nine miles from Baltimore, a wagon crossing over to the wrong side of the road in front of my car necessitated a sudden stop which resulted in the breaking of the left rear axle shaft close to the hub of the wheel. Fortunately, the brake bands held the wheel in place until the weight of the car could be taken by a jack. As nothing could be done with the car in its present condition, a trip was made to Baltimore in another machine to get assistance. I was there informed that the type of axle on my car necessitated the dismantling of the rear axle housing before installing a new shaft, that it was therefore impracticable to make a roadside repair, and that the best thing to do was to get the car to Baltimore. After considering several plans we obtained a heavy two-wheeled baggage truck and returned to the damaged car. Removing the iron feet from the truck, we placed

it with the handles forward under the car so that the axle of the truck came directly under the broken axle. An accommodating farmer gave us some blocks to place on the truck under the axle and also a heavy piece of wood to lay across the sills of the rear doors. By means of old rope we lashed the handles up as high as the footboard would permit and so that the weight would come as much as possible on the heavy piece of wood. The truck was also kept in position by lashings from the handles to both footboards. When the jack was removed the damaged axle rested very nicely on the truck. With the car thus repaired we towed it for about nine miles over hilly roads. Great care was necessary in going down hill to prevent collision with the towing car, as entire dependence had to be placed on the brakes of the right wheel. Before going down one steep hill the tow line was shifted and the damaged car made to tow the other car, the latter holding back when necessary. The use of the truck did no damage to the road.

D. E. T., Washington, D. C.

Some Clutch Trouble

My most interesting and instructive experience in automobile breakdowns occurred while taking a trip from Clinton, N. J., to Birdsboro, Pa. Leaving Clinton on Sunday morning with our car in good working condition, we made the hundred-mile trip, taking in Easton, South Bethlehem and Boyerstown in very good time.

After spending some time at Birdsboro, we started our return trip late in the afternoon, coming back by way of Pottstown, Pa.

Arriving at Pottstown, we stopped at a garage for gasoline and oil. On leaving the garage (this being a strange part of the country to us) I turned the car into the wrong street. In endeavoring to turn, after finding out the mistake, I had to, of course, put the car in reverse. At this operation the clutch failed to release, and shot the car backward over the sidewalk, on a lawn, coming within a few inches of striking the porch of the residence.

Before going to the expense of having the car towed in, I decided I would try to work it to the garage myself. So, setting the gear in neutral position, I started the motor and forced it into low gear. Doing this started the car, and it carried us to the garage.

I could get no help at the garage as it was 7:30 P. M., and the workmen refused to help until Monday morning.

Being eighty-five miles from home and forced to have the

load there by Monday morning early, I went to work myself to tear the transmission and clutch apart. In doing this, I found three plates in the clutch broken, one in six pieces, the others in halves.

The machinist coming around at this time said that the clutch could not be fixed to move the car without new plates. But, deciding that I could repair the clutch temporarily, and get my car and load home, I thought by leaving the two plates which were broken in halves the way they were, as they did no particular harm, and by fixing the others, I could do so.

Taking the third plate, which was broken in six pieces, I discarded three of them, and found that by drilling new holes in the other three I could put them on the studs that the opposite plates worked on, and thus take up the space, still leaving the spring in the same tension.

Now, after doing this, I put the clutch and transmission together, and was ready to test the work. At 11.30 P. M. I started the motor and ran for a distance of five miles around the town and decided the car was safe to carry us home. Returning to the garage, I gathered up the load, packed the car, and left at 12.40 for the homeward trip. With careful running and handling the gear and clutch, I succeeded in getting the load home in good time. Therefore, I learned that by using our own ingenuity we can overcome difficulties which at first seem impossible. WM. J. SEALS, Clinton, N. J.

Brake Condition

I have learned from my "breakdown" experiences on the road to keep my brakes in good working order so that they will stop the car instantly under any conditions. I was touring through New Jersey at the time of my mishap, going from Morristown to Hackettstown. We were going up Schooly Mountain, and when we were about half way up the mountain, at the spot which is known as "dead man's curve," we had to drop from third to second speed, but for some reason the gear wouldn't budge. On applying the brakes I found that they wouldn't stop the backward progress of the car in the least. As several cars were in back of me, I couldn't back down the hill, so I ran the rear of the car into a stump, which put a stop to our backward progress. Looking over the back of the car we could look down on the chimneys of the houses lying below us in the valley. On looking at the brake bands I discovered that they were covered with grease. So when I go out now I always look at my brakes to see if they are in good working order. H. H. WORK, Stratford, Conn.

A Radiator Leak

In breakdowns I have had no experience. I have driven 50,000 miles and never been towed in yet. I have had road troubles, and in Florida, where you can drive 40 miles without any sign of habitation, no phones or railroads, you must have more than a passing knowledge of motors and the parts of a car. Among the first aid to the injured stunts I have used to advantage were:

Radiator sprung a leak. While plenty of water could be had here and there, the leak got so bad that less than a half mile could be made without replenishing, and sometimes it was a hike for a mile to get the water from a pond or stream. Had no bucket. Used the bottom of my carbide generator. As a last resort I used horse manure in the radiator. After boiling same by speeding motor and allowing the water to pass through leak, found the last of the sediment almost completely closed the leak, and when I next filled the radiator the leak had been almost stopped. I was able to come in twenty miles before replenishing.

Another time I was short on gasoline. Like the painter who worked so fast to make his paint last longer, I speeded it up with full spark endeavoring to get into town. A mile out, and a mile from a 'phone, the machine made its last spurt. I took the top off the tank made a cork out of a piece of wood, inserted the tubing off the gas generator through the cork and had my companion blow. This forced pressure on the gasoline brought me into town. Also, I cleaned out the carbureter before I started the engine again—had to. I had blown all the sediment out of the tank into the pipes.

W. B. Powell, Tampa, Fla.

Experience in Mud

Conditions outside the fault of one's car are sometimes met with which tax the ingenuity of the driver fully as great as the most baffling breakdown. Foolishly dispensing with a map, depending upon wayside guide-posts and local information, I started for a place some fifty miles out of town, expecting to make the hotel by sundown. There is an excellent pike to this place, but unluckily we took the wrong lead. The road we stock was one of the worst I had ever seen pictures of. No auto had ever been in those parts. At every stop the natives crowded around in awed wonderment. We had breathed a prayer at every deliverance from successive mud holes. A mile and a half from our destination we dropped to both rear hubs in a lake of gumbo. I worked till dark alone, when two men arrived in a buggy and lent their efforts for an hour without

avail. One went for horses, but returned only with a board and stout rope. They proved of no assistance for another hour of gruelling labor, when I hit upon a scheme. Doubling the rope, the bight was looped over the end of the plank and brought over the top, the separate strands going on either side of the wheel were tied to the spokes at the hub and forced down in the mud to the rim. The turn of the wheel pulled the plank under it, giving it a secure base, and out we rolled. B. L. Forse, Poughkeepsie, N. Y.

CHAPTER XIII

WINTER DRIVING AND MAINTENANCE

MAKING WINTER THE SAME AS SUMMER

IT is a human characteristic to think of one's self first and such things as automobiles later, so the motorist must look into the matter of proper protection to himself and passengers. The first matter which presents itself is that of an enclosure such as a winter top, a new body with permanent roof or an open body with new curtains which are better than the ordinary ones for keeping out the cold. I have concluded that it is utterly impossible to get fireside comfort without a car heater of some type and either a demountable top or a convertible body. Even the latter without a heater makes it necessary for the passengers to take on the appearance of esquimaux. Additional robes, special clothing and shoe covers will not be necessary if the car is enclosed and a good heater installed. There are numerous types of heaters, but the type using exhaust gas is the cheapest to operate and gives excellent results. It is the standard type. There are arguments for and against different forms of exhaust-type heaters such as the register or the foot-rail, etc., but any one of these with a good gas control will make the interior of the car like your own living room. It is necessary to get a good heater because some of the designs either heat too much or little. In the first case the passengers roast and the shoes are scorched and in the latter they are cold. The heater should be one which can be easily dismantled and cleaned so that any accumulation of carbon can be taken out. The carbon acts as an insulator and then the heater is not effective. The fitting of the heater is an easy matter. If it is of the floor type there should be no space around it to permit of cold air and dirt entering the car. Heater prices are comparatively low, ranging from $5 to about $15 for front or rear types. The owner who drives his own car or who is at all considerate of the chauffeur will have a heater installed in the front compartment as well as in the rear.

Driving gloves are a necessity whether the car is heated or not and it will be to the benefit of the particular motorist to examine the newer types made especially for winter work, or

upon inquiry to MoToR information will be given as to prices, materials, etc. In case the use of gloves does not suffice, the market affords a number of devices for warming the steering wheel at points where the hands grip. Most of these devices are operated by electricity taken from the storage battery or in the case of the Ford from the magneto.

A robe is of course essential and if the car is not properly heated an extra robe may be necessary. Some owners are satisfied with one good robe wrapped around them, but the average woman remaining in a car for any length of time in cold weather will require more than this to give the highest degree of comfort.

To the careful driver there is no more danger connected with winter work than with spring touring, but nevertheless due care should be exercised and one way of doing this is to have a windshield cleaner installed, or make some provision for having the shield perfectly clean. Snow flakes mottle the pane so that it is almost impossible for some drivers to see twenty feet ahead unless the shield is opened, in which case the drivers get cold and uncomfortable. There are numerous types of shield cleaners, some good and some worthless. It really does not pay to buy a poorly made one, because when installed it actually becomes a nuisance rather than a benefit.

For safety, comfort and pleasure it is necessary that certain matters pertaining to the car be given due consideration and of primary importance is the cooling system. In fact, when winter arrives the owner's first thought is of an anti-freeze mixture. In the past a great many owners have been making their own solutions from alcohol, glycerine and water, or perhaps just alcohol and water, but during the past year or so, some very excellent anti-freeze compounds have been introduced all ready to pour into the water system. This is much better than making up solution, especially in view of the fact that the cost is about the same or less without the bother. With alcohol used as a base in nearly all solutions and the price of this product being very high at this time, owners may be inclined toward using a substitute such as calcium chloride. This is not advised, however, because of the chance of damaging the engine. MoToR will glady send to interested readers formulae for anti-freeze solutions, or the names of concerns offering made-up solutions and compounds which have proved effective.

Winter work is eased to an extent by the use of a thermostatic control of the cooling water, or a radiator shutter or the combination, but most owners are not in a position to have these installed. Whether a device of this kind is used or not, a radiator and hood cover does much toward keeping the engine warm; in fact, some believe the cover alone sufficient especially

when stops are not of long duration. Nearly every maker of these is in a position to supply them so they fit snugly.

The owner who once has experienced winter battery troubles needs little coaching. A drop in temperature has the effect of reducing battery output and with an insufficiently charged battery and zero temperature there is liable to be freezing of the electrolyte with consequent destruction of the battery. Keep the battery up to charge all the time, and if necessary have the garage or service station charge it once every three weeks. The lights are used more in winter, the battery must supply more current in starting because of the stiffer engine and the cold tends to hold down the output. Under these conditions it becomes necessary to give the greatest attention to the battery.

Pracically all owners are agreed that driving during the winter is just one scare after another unless adequate tire chain equipment is used. Tire overshoes or covers are very useful, and lastly, there is priming equipment so as to facilitate starting the engine. All the joy of winter work is lost if one must half exhaust the battery before the engine will fire. With the battery in the very pink of condition there must be an explosive mixture in the cylinders otherwise the engine will not start. Many owners after a few performances at one a. m. on a zero night vow they never again will take the car out unless there is some provision for getting a fire easily, but the forgetting habit is characteristic of many drivers.

One of the easiest ways of getting easy starting is to use a dash priming outfit consisting of a small tank and control and piping to the inlet manifold. With the tank filled with a highly volatile fuel such as may be bought from an oil dealer, there is in reserve a fuel which will fire in the very coldest of weather. It does not matter so much from which crude the fuel is obtained so long as its initial boiling point is low, which means that it will volatilize at a low temperature. If no fuel of this kind is used then the driver must prime with the ordinary fuel and use a great deal of it so that in the large quantity used there will be sufficient of low boiling point to give an explosion.

In addition to the tank arrangement there is a type of primer which taps the main fuel line. When the primer is operated a volume of fuel is injected into the inlet manifold and with the starter turning the engine over at the same time a good priming charge is sucked into the cylinders. This method does not, however, give any better results than priming through the petcocks, but it is much more convenient since it is operated from the dash. The idea of getting as much heat as possible to the fuel or mixture is good, but some of the devices used for obtaining this result are far from saisfactory. Various methods are employed, most of them depending upon the heat given off from a

coil through which a current is passing. In many of these devices the heat is far too little to have any effect whatever on the fuel.

Of course, initial starting from the garage in the morning, presents no particular difficulties when a garage heater is used or when there is a heater of some sort under the hood to keep the cooling water at a reasonably high temperature, but starting on the street after the car has been standing for a few hours in zero weather is what calls for due care on the part of the owner. It seems childish advice to say that when a garage heater or anti-freeze mixture is not used the radiator should be drained at night to prevent injury to the engine, but then many of the first-timers might overlook this. Also when there is no garage heater and the system is drained at night, hot water should be used in the morning so that starting will be facilitated.

Owners should bear in mind that the starting problem becomes more severe as the temperature drops and as the altitude increases, so that those owners who live in extremely cold sections or at high altitudes should be doubly careful in selecting the proper equipment. The foregoing applies particularly to the motorist who makes as much use of his car in winter as in summer, but much of the advice will apply equally as well to the owner who will use his car at no definite intervals, taking it out as inclination or weather dictate. This owner should make it a point to take good care of the battery, giving it a charge in the car once every week. If a service station is convenient, the battery should be left there and called for when necessary. The tires also will need a little extra attention and it is suggested that they be kept away from the floor by the use of tire-saving jacks. It might be well to remove them on the rims and place them in a dark room, but then there is the bother of remounting. This owner should have a quantity of anti-freeze solution either in the car or ready to be poured in. The latter is best because when in a sealed can there is less evaporation.

It is quite true that the number of cars is exceedingly small which in these advanced days is propped up on jacks awaiting the coming of the ground hog, but then their owners have a few matters which require their attention. Driving the car into the garage and leaving it there until spring is to increase the rate of depreciation considerably, but while this sort of practice is rare it nevertheless is not far removed from that in which the owner does everything necessary for the complete protection of the car and its accessories.

If a car is to be laid up all winter it is necessary, of course, to drain the gasoline and water systems completely, leaving the caps off so that any remaining liquid which cannot be drained will be evaporated off. The oil in the engine, in the clutch, gearset and rear axle should not be drained, in fact, it even is a

good plan to fill the gearset and rear axle completely, so as to cover the gears entirely. The car should be given a thorough cleaning, starting with a good wash all over body and chassis and then going over it again to remove all caked mud and dirt in corners and crevices. With the car as clean as you can get it, jack up all four wheels, remove the tires with rims, and take out the tubes. The latter should be partly inflated, just sufficient to give them normal shape.

The casings should be wiped clean. Both casings and tubes should be covered with cloth and placed in a dark room in the house. If desired the tubes may be inserted in the casings and stored in the same fashion. Parts which are likely to rust should be cleaned, dried and spread with cup grease or vaseline. The storage battery should be removed and taken to a battery service station. Here obtain the advice of the manager as to the best way to store the battery, whether in a dry state, dismantled, or as it is. All terminals disconnected should be cleaned and spread with grease.

Some owners, who are fortunate enough to have work shop facilities, spend their spare time during the winter making necessary repairs. Whether work is done or not the whole car should be covered with a special paper cover or with cloth. One of the most disagreeable tasks is to work around a car in a cold garage, so the imperativeness of a garage heater at once becomes apparent. There are numerous types including those using coal, kerosene, gas, hot water, etc.

COLD WEATHER STARTING

THE difficulty of starting a gasoline motor in cold weather is due to two causes: first, the gasoline being cold does not vaporize so readily, and second, it is a well-known fact that cold air has not the same power to hold or take up liquids in suspension as has warm air. In other words, its saturation point is lowered at reduced temperatures.

It is the combination of these two causes, aided by a cold motor and piping, which make it so difficult to start the motor in cold weather. The best method of starting a motor will vary with the type of carbureter used. Where both the initial and auxiliary air enter by a common opening, any system of choking this opening will usually suffice. Where, however, the auxiliary air supply is separate; it serves no useful purpose to choke or strangle the main air passage, for then the motor will simply take its air (and no gasoline) through the auxiliary air valve.

In most cases a small oil-can filled with 76° gasoline will help considerably, by making it easy to prime the cylinders through the priming cocks. One of the most reliable ways of starting in cold weather is to drill a hole in the intake manifold, directly above the vertical tube, and fit this with a priming cock. Open the cock and insert the oil-can filled with gasoline into the opening, then close the throttle almost completely. The gasoline will run down the side of the intake pipe and accumulate above the closed throttle. Upon cranking the motor the velocity of the inrushing air is highest just around the edges of the almost entirely closed throttle, and if there is any gasoline at this point it will invariably start the motor. After the motor is well started remove the priming can, and don't forget to close the priming cock.

R. F. B., St. Louis, Mo.

High Test Auxiliary Tank

The difficult starting of a gasoline engine in cold weather is due to several causes, the chief of which is the fact that the gasoline is not readily evaporated in cold air. The process of evaporation or vaporization requires heat and induces a lowered temperature in the surroundings, as can be observed readily by feeling of the carbureter on even a hot summer day after the engine has been run awhile. The grade of gasoline used also has a great deal to do with the ease of starting a motor in cold weather. With the common and poorer grades of gasoline, which are approaching nearer to kerosene each year, the difficulty of starting is becoming more pronounced, since the poorer the grade of gasoline the more heat is required to vaporize it.

To overcome these causes of poor starting there are several methods of procedure which I shall outline below:

1. Keep the car in a warm place over night and do not allow it to stand for long intervals in the cold outside air with the engine stopped.

2. Use a very high test gasoline in the cold weather. The great drawback to this method is the very high cost and the difficulty of obtaining and keeping this grade of gasoline in quantities.

3. Inject into the cylinders themselves a sufficient amount of gasoline so that enough will vaporize and mix with the air enclosed to form a mixture that will explode and start the engine.

4. Obtain a carbureter so designed that a sufficient velocity of the incoming air past the spraying nozzle can be obtained upon cranking the engine to carry enough gasoline in the

form of a mechanical mixture into the cylinders to form an explosive mixture with the air enclosed.

5. Inject a small amount of ether into the carbureter just before cranking the engine. This method will be found to work well, but care must be taken not to inject too much.

6. The method which I now give I believe to be the only logical solution of this starting difficulty for a car which must be run under the average conditions have a small auxiliary supply tank on the car in which to carry very high test gasoline. Connect this tank with the carbureter, as well as the regular supply tank, so that either grade of gasoline can be let into the carbureter by means of a cock which can be located on the dash. The feed can then be shifted from one tank to the other so as to get the high test gasoline for starting.

ROY A. WHEELER, Milwaukee, Wis.

"Many Inventions"

Since gasoline does not vaporize at low temperatures, and since it is explosive only when in the form of a vapor, it follows that a cold engine will not start as readily as a warm one.

Definite methods of cold weather starting may be classified as priming, with gasoline or something else, and applying heat so as to render priming unnecessary. When we prime a cylinder with gasoline we introduce a much larger quantity than is necessary to one explosion, and because of the large amount there is a certain amount of vapor formed in spite of the low temperature. When the motor is cranked and a spark occurs there will be an explosion which will heat the cylinder a little so that of the next charge introduced, whether by means of the priming can or from the carbureter, a larger proportion will be vaporized. It will be evident that if the motor is cold enough this process will be of no value. If the priming be done with high test gasoline or with either, both of which vaporizes at lower temperatures than the standard grades of gas, priming will be more effective, or will be effective at a lower temperature. If the priming be done with an explosive gas, as acetylene, which retains its explosive qualities at low temperatures, it will make little difference how cold the motor is, but enough of the gas will need to be supplied to run the motor until it is fairly warm.

If on the other hand we heat the cylinders enough, through the water jacket, priming will be unnecessary.

If, however, a non-freezing mixture is being used in the cooling system, it is decidedly unhandy to drain it out, put in hot water, start the motor, drain out the hot water and re-

place the non-freezing fluid. In some motors this may be avoided by applying heat to the carbureter and the intake manifold. In one case a teakettle of boiling water poured over carbureter and intake has been found an almost infallible method of getting the motor to start.

The routine use of high test gasoline in winter will do much to make starting easy if one cares to pay the price. It is in effect the same thing as raising the temperature several degrees, as it volatizes at a much lower temperature than the standard grades. Or, a tank with a little high test gas in it may be installed on the dash and piped to the cylinders so as to inject a charge of it into the cylinders when desired. Of course the priming can will do the same thing but this is much more convenient. Many of the ignition starters now in use have a means of feeding acetylene into the intake until the motor is warm enough to use the gasoline vapor from the carbureter. In fact we have numerous acquaintances who have installed and are using ignition starters solely as priming devices, believing "starting on the spark" to be injurious to the motor.

There are now on the market electrical devices which undertake to keep the water in the cooling system at a temperature which will make for easy starting no matter how cold the surrounding air. An ingenious adaption of this idea is to wrap around the lower water pipe between the radiator and engine one of those electric "hot water bags," leaving the current turned on enough of the time to keep the water warm. This scheme is cheap, clean, and does not interfere with the use of a non-freezing fluid.

It is of course difficult to say to what extent the ignition starter will supplant, this winter, the teakettle and the priming can, which in previous winters have been the stand-by of the cold weather motorist.

Dr. C. D. Enfield, Jefferson, Iowa.

CURES

In order to obtain a good "explosive" mixture, it is necessary to have gasoline vapor combined with air in the proper proportions, or within the rather narrow limits between a "rich" and a "lean" mixture, and because gasoline does not readily vaporize at a low temperature, it is somewhat difficult to obtain a mixture that will "fire" on a cold day.

The writer understands that "self-starters" are not to be considered in answering this question, since the turning of the motor by electricity, air or springs—or the warmth produced by explosions of acetylene modifies the problem a good deal,

hence we will confine our discussion to the regular, old-fashioned "turn-the-crank, Jimmy" kind of car.

There are two general methods of procedure in trying to obtain a starting mixture during cold weather. One is to get a greater amount of gasoline into the cylinder, hoping thereby to get enough vapor to "start something" and the other is to warm the carbureter intake or cylinders, or all of them, so as to produce better vaporization, without introducing extra fuel.

Perhaps the commonest known method of adding gasoline is that of dropping a spoonful or two into each petcock, if the car has any, and then turning her over to get the liquid down. This is not always so easy as it may sound, and in some cars most of the "gas" is apt to leave by way of the exhaust valve route. Some drivers remove the spark plugs, and inject the liquid with an oil gun; but this method is laborious, may result in getting in entirely too much gasoline, and may also result (remember your hands are cold!) in a cracked porcelain, and broken resolutions about language. Both of the above methods, however, are used by many drivers with success.

Some carbureters are equipped with regulating devices which can be set so as to furnish almost any desired amount of "gas," and the difficulties are slight in such cases.

The writer has found that a very simple and effective method can be used with some cars, as follows: Saturate a piece of cloth with gasoline, and place it so that the air entering the auxiliary air valve must pass through or around this cloth, but do not let the cloth be drawn in so as to stop up the intake passage. Then "spin" the engine as rapidly as possible, and frequently it will start after a few turns. Remove the cloth slowly after the engine is going well.

The simplest ways of heating the carbureter, cylinders, etc., are to wrap hot cloths about them, and to pour hot water into the circulating system and "turn her over."

L. I. W., New York City.

ANTI-FREEZING SOLUTIONS

VIEWED from a practical experience the use of anti-freezing solutions in the cooling system of an automobile has been of such benefit as to make any question of its being worth while seem forced. Driving a car all the year round, keeping it in an unheated house, in a latitude where the thermometer has been known to touch ten below zero, it has been a case of drain or

use "anti-freeze." Draining the car is a nuisance, and one always has the fear that a pocket is left full of water. In addition, when standing idle, out in freezing weather, the engine must be heavily blanketed; or started frequently. And it is always on your mind.

The disadvantages of an anti-freezing solution are nil if the proper article is used. Glycerine attacks rubber and is comparatively costly. Calcium chloride *will* form crystals which are disquieting to behold every time the filler cap is removed, and must eventually lessen the efficiency of the radiator, if nothing worse.

Alcohol, in its denatured form, is a very cheap insurance against cracked cylinders, leaking radiators, and damaged pumps. Theoretically, it lowers the boiling point of the cooling compound; practically, there is nothing abnormal in the running conditions, as the colder weather offsets the drop. Alcohol is clean, non-explosive, and does not injure the hands. Its presence in the water system is evidenced only by the smell. Forty-five cents a gallon, and from three to four gallons being ample for a winter's use, in a tight system, makes its cost inconsiderable.

The proper way to use alcohol for an "anti-freeze" is to add in small quantities, say about two quarts at a time, from the period when freezing may be expected, till the maximum amount needed, for the coldest weather known to the region in which the car is used, has been put in, and then ,as spring approaches use water only when replenishing.

A good way to insure peace of mind, is to draw off from the radiator some of the liquid, add one-quarter its volume of water, put in a bottle, cork, and set outside one's window. You then have a gauge which will give ample warning. Of course, as you change the mixture, refill the bottle. At the risk of inviting carelessness, let it be known that when the compound does freeze, it will not be a solid, but slush, through which a finger may be easily thrust, and which would seem to possess little or no "bursting" power.

The following table is sufficiently close for all practical purposes.

10%	mixture	freezes	at	about	+25° F.
20%	"	"	"	"	+10° F.
30%	"	"	"	"	— 5° F.
40%	"	"	"	"	—20° F.

HENRY MOORE, N. Y. City.

No Question About Its Value

From the viewpoint of a medico, who belongs to the most practical class of motorists, there can be no question as to

whether an anti-freezing solution should be employed or not. To the motorist whose car is a means to his livelihood, protection against freezing is absolutely indispensable. The machine must be ready for service at all times—it must frequently be abandoned just as it stops at the patient's door, and it is nothing unusual for it to stand for hours at a time unprotected. Unless safeguarded by an anti-freezing solution damage is sure to result, sooner or later. Draining the radiator at night is out of the question; the car may be needed for an emergency call at any hour, and much valuable time would be wasted in filling up, not to speak of the inconvenience.

Even if draining and re-filling were merely a matter of turning a faucet, there would be little excuse for not using an anti-freezing solution instead. But neither operation is so simple, every car that I have had any experience with has had one drain cock in an inaccessible position. Getting at it meant dirtying a glove and sleeve or burning one's hand against a hot part of the motor in an attempt to save the glove.

When I first discarded the buggy and "hay motor" for a gasoline runabout, I experimented with several different anti-freezing solutions—in fact, all of them that are commercially practical. As a result of this experience, I settled upon a solution of glycerine, denatured alcohol and water, and it has always proved effective as a preventive of freezing and generally satisfactory from the practical point of view.

The radiator of my car holds fourteen quarts, or three and a half gallons. On the approach of cold weather, two quarts of glycerine are added. This replaces a little over one quart of water when liquefied under the influence of the heat, i. e., it becomes a much thinner liquid than when originally put in the radiator. With the next drop in temperature, another pound of glycerine is added. All of this glycerine is first tested for acidity with litmus paper, and if at all acid it is neutralized by the addition of a small amount of a saturated solution of bicarbonate of soda. This may be prepared at a cost of ten cents by dumping a pound of bicarbonate of soda into about two quarts of water. Neutralizing the solution prevents damage to the hose connections. An M. D. cannot afford to have his car spring a leak unexpectedly.

With the addition of the third pound of glycerine, the solution is about 10 per cent. proof, and is effective protection against early winter temperatures, say down to 10 or 15 degrees Fahr. At the time when real cold weather is due, a gallon of denatured alcohol is substituted for that much water in the radiator. It will be apparent that drawing off this water takes with it a proportionate amount of the glycerine, say one pound. The solution is then composed of four quarts

of alcohol, one quart of glycerine and nine quarts of water. In other words, more than 33 per cent. of it is liquid that will only congeal at a very low temperature, so that the freezing point is considerably below zero and consequently safe in all weather encountered in this part of the country. The solution is kept up to its original degree of efficiency by addition of denatured alcohol from time to time. If preferred, glycerine can be depended upon altogether. Its chief value in connection with denatured alcohol is that it raises the boiling point of the solution, thus counteracting the effect of the alcohol in this respect and prevents the latter from boiling away too fast. HARRY P. EVANS, New York City

Extensive Experience

The temperature in Detroit during the winter months for several years past has never gone lower than five or ten degrees below zero.

The Detroit Taxicab Company, which was formerly called the "Auto Express Company," and carried on a package delivery business, has always had more or less trouble with radiators freezing during the very severe winter. One year we tried to get along without any freezing solution whatsoever and instructed drivers to allow their motors to run while the cars were standing still. It is needless to say that we had our troubles during that winter.

We have tried nearly everything that has been suggested for a non-freezing solution, such as calcium chloride, glycerine and wood alcohol, glycerine and water and denatured alcohol. Last winter we ordered from the Michigan Drug Company some seven or eight barrels of denatured alcohol, and it was the first winter we have gone through where we have had absolutely no freezing radiators. During the winter of 1908, we used glycerine and water, and we found that the glycerine in a very short time would eat or rot the hose connections which connected motor with radiator, and solution would be lost, and we also found that glycerine would eat out some of the soldering and allow the solution to leak out. Last winter, as stated, we used denatured alcohol *only* and had absolutely no trouble and we have this year ordered five barrels from the Michigan Drug Company as an installment for our winter use.

We have some sixty-five cars, four of which are used by the United States Government for the carrying of mail between the main postoffice and sub-stations, and the balance of the cars are taxicabs and touring cars; these cars are all manu-

factured by the Olds Motor Works, of Lansing, Mich., and their radiators have a capacity of about five gallons.

During the severe weather when the thermometer is hovering somewhere about five degrees above zero, we watch our solution very carefully, and we have two hydrometers for testing it, and on account of some evaporation of the alcohol we test every day.

After having tried calcium chloride, glycerine and various non-freezing solutions, which have been offered for years past, we do not hesitate to say denatured alcohol is the only product we have ever been able to use and use successfully. Last year we purchased, as said before, a number of barrels from the Michigan Drug Company, and I think the price we paid was 43 cents per gallon; this year we have placed our order, as already noted, for five barrels at 43 cents per gallon.

We have never used oil for a non-freezing solution, but have seen it tried with very disastrous results. In one particular instance I recall where a car came into the garage and was allowed to run for some little time in a heated room, and the oil overflowed the tank in some manner, and set the car on fire.

I. S. Scrimger,
Gen. Mgr. Detroit Taxicab Co.

Reserve Tanks Used Vulcanizer to Heat Mixture

The feeling that a reserve supply of gasoline and lubricating oil gives is not, to say the least, depressing.

As the supply of our car was not up to the standard, I procured a five-gallon and a one-gallon can and some ordinary copper tubing. The cans I securely located under the rear seat by strips of sheet iron bolted onto the body. Then I connected the main tank to the reserve (as it now was), adding five gallons to the capacity of our car.

The smaller tank I connected to the crank case by boring a hole about two inches below the cylinders, making one joint in the line, where I placed a switch to reserve the lubricating oil until needed.

An ordinary vulcanizer can be and was used by myself to heat the mixture in cold weather in a very short time, to such an extent that the engine started very easily, the vulcanizer laid or tied against the carbureter, with a cloth wrapped around.

O. W., Baltimore, Md.

SURE SHOT STARTING IN WINTER

THERE is one substance which, when used as a priming fluid, will give firing on the first turn over in the coldest weather which prevails in our states, and that substance is ether. This may be commercial ether, or petroleum ether, a highly volatile product of petroleum. Its use even in weather as cold as fifty degrees below zero will give sufficient vaporization without the use of outside heat to start the motor, providing of course that there is a spark to ignite the charge. This liquid may be purchased in most good drug shops. The same results will be had by the use of 76 degree gasoline, and this must be bought from an oil dealer or drug shop. These liquids may be used alone or mixed with an equal quantity of ordinary gasoline, but it is evident that better results will be obtained by using them unadulterated.

The priming with ether may be done in the regular way by allowing a small quantity to flow into the cylinders through the pet cocks or other cylinder openings, but a much better and simpler method is to install a dash priming outfit. If the owner does not wish to install the dash primer, a small supply of this liquid may be carried in an air-tight can under the seat or in a pocket, and when it is necessary to prime a little may be poured into an oil can.

However, the priming can on the dash not only makes a convenient holder for a season's supply of the priming fluid, but also makes starting easier because it may be operated from the seat.

Many run into the error of believing that the gravity of the gasoline purchased is a true indication of its volatility, and hence its easy-firing ability, but this is not quite true unless perhaps the comparison is made between gasolines obtained from the same crude. It is wrong to suppose that gasoline of 65 degrees obtained from western or Texas crude will give the same results in starting as gasoline of the same gravity obtained from Pennsylvania crude. It is unfortunate that the only true indication of the easy-starting abilty of gasoline is its initial boiling point, because when purchasing gasoline one cannot tell what the initial boiling point may be. Gasoline is a mixture of various compounds, and when gasoline is heated, the lightest of these compounds is first evaporated off. As the gasoline is further heated, a slightly heavier portion evaporates, and as heating continues the heavier and heavier portions follow. When the initial boiling point is low, from 75 to 85 degrees F, the fuel will fire easily because a certain portion of it volatilizes at a comparatively low temperature. When the initial boiling point is high, a great deal of heat is necessary to get any of the liquid to volatilize, and in the gasoline

now being sold in the east (60-65 degrees Baumé) the initial boiling point is high. In other words, this so-called low-grade gasoline does not contain enough of the low-boiling point liquid, and hence when it is desired to start we must either get enough heat to the fuel so as to strike its initial boiling point, or we must prime with it in the hope that in the fuel used for priming there may be a little of low-boiling point which will start the firing.

Many owners find it unnecessary even to prime the cylinders with ordinary gasoline or a fuel of high volatility because the car is not left standing long enough. There really are a few problems to be discussed. There is the owner who in cold weather never allows his car to venture more than a mile from the garage, others who curb the car for four and five hours and still others who keep the motor running for the few hours the car is used at night. Some do not care to use any but the old-fashioned methods of obtaining easy starting, while others insist upon a dash primer and various fuel-heating appliances.

What the motorist is most concerned with is to obtain easy starting after the car has been standing for a few hours in the open. In the garage during the day the situation is more easily controlled. However, the early morning start even from the garage is sometimes attended with difficulties, which many of us have not been able wholly to overcome. If a reliable heater is used in the garage, there should be no trouble for the temperature of the building may be kept at any desired point, so that starting is no more difficult than on a warm day. There are many owners, however, whose garages are barns, unheated and perhaps not completely tight to the assaults of wind and weather. For the owner of this type of car shelter, the time-honored and still reliable methods of encouraging vaporization are best. Where an anti-freeze mixture is not used, the radiator should be drained every night. When such a mixture is employed, the draining may be done in the morning and into the empty water system boiling water is poured, producing enough heat to make starting easy, especially if the cylinders are primed in the ordinary way and the carbureter air choker is closed. After the start is assured the anti-freeze mixture is returned to the water system.

Some owners drain the motor at night and start in the morning by flooding and priming, allowing the engine to run with an empty water system for a few minutes. This gives the metal a chance to absorb some heat and the motor is thus quickly warmed.

With the fuels that are generally used at the present time, a great deal of heat is necessary to give satisfactory results. Obviously in these circumstances the mere wrapping of a hot cloth around the manifold is not enough. This method heats the manifold slightly, but not sufficiently to vaporize any portion of the present day low grade fuel. Moreover, this

method is only applicable to garage use, as few of us can obtain hot cloths when we happen to stop in the street. The needs of the case really simmer down to an extremely volatile fuel such as petroleum ether or a very hot manifold, the heat of which will vaporize a much heavier fuel. This latter condition may be produced by playing a blow torch on the manifold, but this procedure is a little dangerous to be recommended to the average car owner. At any rate the whole problem with heavy fuels is to get a sufficient degree of heat in the carburetion system to give partial or total vaporization of the fuel. Lacking heat we must get an excess of ordinary fuel or a little fuel of high volatility into the cylinders.

Many makes of cars are not fitted with really efficient carburetors having dash air controls, and this makes the ordinary starting problems all the more difficult. On the other hand some modern motors are not easy to start, even with controls of all kinds. One of the best things an owner can do, whether he has an old or a new car, is to install a priming device of some sort which may be operated from the seat. A device of this sort having especial merit consists of an air-tight metal container holding about two quarts and connected by one pipe with a hand pump which protrudes through the dash and having access to the intake manifold through another pipe. By operating the pump plunger, gasoline or a mixture of gasoline and petroleum ether is forced directly into the manifold. This type of primer may be used with a fuel of high volatility and two quarters of it should last for a long time.

Where an electric system is used starting becomes as easy in winter as in summer, when an injector and a light fuel is employed as indicated above. Manufacturers of motor car accessories are fully aware of the efficiency of this type of device, and many of them are now offered which require little time for installation. If the owner is handy with tools, it is an easy matter for him to construct such a priming outfit.

Such a device and liquid should be particularly desirable when the motor is not fitted with priming cocks or combination spark plug and primer. In the Ford for example one must remove the spark plugs to prime the cylinders, and hence a dash primer will facilitate matters greatly. Even where priming cocks are used, the dash-controlled device is preferred because it offers an easy method of carrying a supply of high-volatility fuel, and does not require lifting the hood.

Aside from the priming idea special heating devices have some value. In most of these electric current is used to bring a heating coil, within the manifold, to a high temperature, and as the air becomes heated it offers an opportunity for the fuel globules to

become vaporized. There are a number of air and fuel-heating devices on the market, some of which have merit.

It would be the ideal condition if the temperature of the water in the jackets could be kept at a predetermined constant degree, obviating any difficulty in starting from the curb, but unfortunately this is not now possible. We can, however, keep the temperature of the water up; that is, we can prevent the water from getting cold when the motor is not running by properly covering the radiator and hood. These overcoats, as they might be called, keep out the cold, and it is possible with a good tight-fitting covering to retain the water temperature at a high degree for many hours. Where the carbureter is waterjacketed, there is some heat ready for the next start. Often, however, the car is left standing so long on a cold day that even the radiator cover is not enough to keep out the cold with the result that the water temperature drops, and you have a cold motor. Then resort to the methods previously described of using a primer, air or fuel heater, etc.

The hard-starting problem will be more severe in some sections of the country; in fact, the problem really changes as the fuel, air temperature and altitude, and since these are different for different localities each one will have separate problems. Cold, as we all know, increases the viscosity of gasoline; that is, it makes the gasoline heavier and gives it more resistance to flow. The colder molasses gets, the thicker it gets. When it is cold it does not flow as readily as when warm or hot, and precisely the same condition exists with gasoline. When it gets very cold, it is difficult to break it up and make it flow freely through the comparatively small orifice in the carbureter. In cold weather we need an excess of fuel in the cylinders for easy starting and the cold weather works against us by making it hard to get that excess of fuel into the cylinders, because the fuel when cold is more viscuous than when warm.

If you start out with a poor grade of fuel and it gets very cold, the poor grade becomes poorer and hence starting difficulties are multiplied. Even when the carbureter choker is set so as to cut off the primary air and thus cause all the suction to be exerted on the nozzle, it is hard to lift a sufficient amount of fuel through the manifold into the cylinders. Hence priming is resorted to.

Years ago we bought fairly good gasoline all the year round and starting troubles in winter were not so frequent, but now we have a much poorer grade of fuel and our winters are just as severe.

Coming back to the locality question. In the higher altitudes vaporization is more complete than at sea level, and hence the drop in temperature is greater than at sea level making starting

harder. With the temperature at New York the same as that at Denver and the fuels the same, it will be harder to start the engine in Denver. Owners of cars operated at high altitudes must ordinarily run richer than those run at sea level. In winter when the sea level owner must run rich, the altitude owner must run richer, and for initial starting the problem is just the same. Hence the owner in Denver and similar sections should have great need of a dash tank and some petroleum ether.

The winter starting problem then resolves itself into this. Get heat to the air, and to the gasoline directly or by contact with a heated manifold or heated plug; get an excess of fuel into the cylinders by priming, or introduce a little fuel of high volatility, such as 76 degrees gasoline. The carbureter should be one fitted with a hot air tube and also jacketed for exhaust gas or water and should have an air control. To keep the water temperature as high as possible when standing on the street for a while a radiator and hood blanket should be used.

HEATING THE GARAGE

IF the small private garage is to be used during the winter, any car owner of experience will understand the necessity for heating it. The cold garage causes many ills besides the obvious one of freezing up the radiator of the car. In most cases it will cause more than enough damage and inconvenience fully to have paid for a complete heating plant. Most of the starting troubles so generally complained of in winter may be traced back to the cold garage. A sudden drop in temperature is bad for the parts of the engine and for the finish of the body, which are susceptible to marked expansion and contraction through such changes in temperature. During the long nights of winter great drops often occur and a garage that is unheated subjects the car to unnecessary and dangerous tests. Ice in the batteries is another recognized evil resulting from the cold garage. Also there is the inconvenience of washing when the car is covered with frozen mud. If the car is cleaned with warm water to remove the mud and the garage is cold, the paint and varnish are apt to suffer serious damage.

If, on the other hand, the garage is heated, all these difficulties and damages are obviated. The place is made comfortable as a work room and many little odd jobs may be attended to which would otherwise have to be transferred to the repair shop, to the pecuniary disadvantages of the car owner. With the car stored in a warm room, not only are the paint and varnish conserved, but the oil retains its fluidity instead of becoming gummy and

the general condition of the car is maintained at a point where ordinarily satisfactory service may be expected.

Small private garages may be heated by a gas, oil or coal stove or by direct steam or hot water taken from the house and run out on a separate pipe from the boiler. The ordinary types of kerosene oil stoves or the common types of gas stoves are not satisfactory for the garage, because they are too dangerous a fire hazard. However, there are specially designed oil and gas stoves which can be used satisfactorily.

One of the best types of gas burning garage heaters is a small warm air heater which uses either artificial or natural gas. It is so constructed that it is safe in the presence of inflammable or explosive gases. This is accomplished by having a double set of finely perforated brass screens across the air opening which feeds the burner. This permits the air to enter for feeding the flame, but allows no flame to pass backward through it. No matches are ever used to light the flame, but a rotary wheel and friction metal are set near a pilot light which can be ignited by a quick sharp twist of the wheel. The pilot light then is used for catching the main burner. The entire combustion chamber is covered with a metal casing. The burner heats an inner drum of sheet metal which is encased with an outer metal covering allowing an air space between. The ends are made of cast iron. The cold air enters at the bottom of the heater and the hot air passes out at the top, so that it can be set up against the wall of the garage and the car run close to it without blistering the paint. The hot gases generated at the burner, after having given up most of their heat in the inner drum pass out through an outlet at the bottom rear and up through a four-inch vent pipe placed at the end of the heater and extending through the roof.

For a garage with a floor area of about 350 square feet, which would include garages 14 feet by 24 feet, 16 feet by 22 feet, 18 feet by 20 feet, or 19 feet by 19 feet, a heater of this type sufficient for warming would take up a floor space of 13½ inches by 45 inches. It would be 40 inches above the floor and require a 4-inch vent pipe and a ¾-inch gas supply pipe if natural gas is used, but if artificial gas is supplied the pipe must be increased to 1-inch. For garages of about 550 square feet, including those of the following sizes: 18 feet by 30 feet, 20 feet by 28 feet, 22 feet by 26 feet, or 24 feet 24 feet, a heater of the same width is required but 57 inches long. For larger garages of an area of about 900 to 950 square feet, including such sizes as 24 feet by 38 feet, 26 feet by 36 feet, 28 feet by 34 feet, or 30 feet by 32 feet, a much larger heater is required, which takes up a floor space of 23 inches by 42 inches, and requires a 5-inch vent pipe and a natural gas supply pipe of 1-inch and artificial gas pipe of

1¼ inches. Where the climate is extremely cold, larger gas pipes should be used than those indicated to prevent freezing.

Another type of gas heater has the appearance of a cast iron steam radiator. Inside of the radiator at the base is a mixer and burner. This possesses no protective flame device, but the gas is lighted at an opening in the end, and the air is drawn through port holes to feed the flame near the bottom. It passes up through the columns of the radiator and out through a vent pipe connected near the center. The flue outlet is about 2 inches to 3 inches in diameter, depending on the size of the heater. The radiator is built up in sections from two to eight in number. There are two heights of sections, one 27 inches, which has four square feet radiation, and another 38 inches high which has five square feet radiation per section. Depth is 10 inches. The size and number of section required is figured in the same manner that a steam radiator is figured as shown later in this article.

A gas-burning attachment may also be added to a coal stove type of heater. Likewise the use of crude oil as a fuel for heating the garage can be set into a typical coal stove heater. The difficulty of using crude oil for a burner is that it should be stored outside of the building in the same manner that gasoline is stored. The fire underwriters recommend that it be placed no nearer than 30 feet to the building and buried at least two feet below ground. Of course, a crude oil burner is a much easier method of securing heat than by coal, but it is considerably more dangerous to handle around the garage, and it is not a fuel that can be obtained conveniently in all localities. If crude oil is burned as a fuel, in any particular district, it generally is used in the heating plant of the house, and it will be better to run an extension of this plant out to the garage in the form of steam or hot water radiator. Oil stoves which have the storage of oil in a reservoir connected with them are very dangerous from the standpoint of fire. The common kerosene stove, although it is used, is not a satisfactory type for the garage. Not only is it dangerous to leave burning without someone around, but in a small garage where the windows are closed on severe winter days the air is fouled very rapidly and thus the garage is made an unhealthful workshop.

The old-fashioned coal stove still produces as satisfactory a method of heating a small building like a garage as any form invented. The coal can be kept burning constantly, and hot water connections can be easily installed. With heat constantly supplied, plumbing fixtures can be installed in the garage such as a sink and water closet. The air is kept sweet and clean, and by a pot of water set on top of the stove the moisture is retained in the air, preventing the very dry heat which is so harmful to the varnish on the car and unpleasant to work in. If there

is a room above the garage, a register can be placed in the floor to heat it.

In most cases it is not necessary to build a brick chimney for the coal stove, an iron smoke pipe being satisfactory. Where the stove is large and must heat a fair sized garage it would of course be better to build a good chimney.

In setting up the stove, it is best to place it at the rear end of the garage it would of course be better to build a good chimney.

In setting up the stove, it is best to place it at the rear end of the garage and in one corner. A metal screen is useful to set up around the ash pit door and no ashes should be dumped out fresh and allowed to stand around inside. Where the garage is a wooden structure, plaster board and sheet iron should be nailed to the walls near the stove for protection.

The actual dimension of the stove necessary properly to heat a garage depends upon its location, size, material of which it is built, etc. As a general guide, however, the following will give some idea of the necessary size. These sizes assume that the garage is built of brick. For a garage about 350 square feet in size and approximating the dimensions noted for the gas heater, a stove should be secured which has a fire-pot of about 14 inches in diameter. The 550 square foot size requires a 17-inch fire-pot. A double garage about 850 square feet in size requires a 19-inch fire-pot. When the garage is as big as 1,050 square feet. the stove should be clad in sheet metal and have a fire-pot of 20 inches. For an area of 1,360 square feet a 22-inch fire-pot is good. From these figures an approximate estimate of the size stove necessary to install may be figured. A little common sense must be used, and the material of which the garage is built and its location considered.

If a steam pipe is to be run out to the garage from the house, the number of square feet of radiation must be calculated which will be required to heat the temperature to the desired degree. When this is known the size radiator can be quickly determined. A cast iron one can be used or a pipe coil set up on the wall. The gas radiator already mentioned can also be estimated in size, and this installed.

The following rule should be used to determine the size radiator necessary. Find out the total number of square feet in the windows and door. Subtract this from the total number of square feet of all the four walls and roof, if it is an exposed type and not plastered. This will give the actual number of square feet of wall excluding the windows and door. Divide this amount by ten if the walls are approximately eight inches thick. Add this to the total amount of square feet of window and door surface previously estimated. Now multiply this

figure by seventy-five. This product will be the number of cubic feet of air which are cooled per hour in the garage. Add to this the volume of the garage and this will give the total quantity of air to be heated. Generally it is heated to a temperature of fifty degrees when it is zero outside. Finally, to determine the number of square feet of radiation necessary, multiply this quantity by .009, which will give the desired answer.

Now, a radiator having this number of square feet of radiation must be selected. If it is an ordinary cast iron radiator, this will be listed in the manufacturer's catalogue. On the other hand, if the radiator is to be made of pipes and hung on the wall, the number of feet of pipe necessary will have to be estimated. To obtain this multiply the square feet of radiation by:

3 to give No. ft. of 1-inch pipe necessary.
2.3 " " " " " 1¼ " " "
2 " " " " " 1½ " " "
1.6 " " " " " 2 " " "

For an example of figuring the size radiator necessary for a garage take a typical size thirteen by twenty-four feet with eight inch brick wall ten feet high and a pitched roof with flat plastered ceiling and attic above. It has a door ten feet wide by eight feet, six inches high, and four windows two feet by four feet. To determine necessary size of radiator take the following steps:

1. The total number of square feet in the windows and door will amount to 117.
2. The garage is thirteen feet by twenty-four feet. Allowing for eight inch thick wall, we have about 71½ feet of it. This multiplied by ten feet, its height, will give 715 square feet of wall including doors and windows. Subtract from this 117 determined above and the result, 598 square feet, will be total number of actual square feet of wall.
3. Divide this 598 by 10 and get 59.8.
4. Add this to 117, the door and window surface, and get 176.8.
5. Multiply 176.8 by 75 and get 13260.
6. Add to this the volume of the garage which is approximately 13 by 24 by 10 feet, which gives 3120. Adding this to 13260 you get 16380.
7. Multiply this by .009 and get approximately 148 square feet of radiation necessary to heat the garage.

If a cast iron radiator is to be selected to meet this requirement one of sufficient size must be selected from the catalogue. Suppose a four column forty-five inch high radiator is to be used, and in the catalogue it is found that one section of such a radiator has ten square feet of radiation per section. Then dividing 148 by 10 a radiator of 15 sections should be used. This will be about 10½ inches wide and 45 inches long.

If, however, a system of pipe coils is used, shaped in a trombone pattern, less space will be taken up. Suppose a 1½ inch pipe is to be used. From the table the number of feet necessary will be 148 multiplied by 2, which is 296 feet of 1½ inch pipe. This can be set up in short or long runs as desired.

If a hot water system is used in the house, the radiator in the garage must also be a hot water type and the necessary radiation increased. Figure just the same as for steam but then increase it in proportion. The radiator should be 1½ times as large as the one required for steam.

In making the extension of this radiator to the garage a greater burden is added to the boiler in the house. If it is so great an added burden as to upset the house heating it should not be done, and some other form ought to be installed. In putting in a boiler for the ordinary house, allowance is made for overrating of the boilers by the manufacturers. The entire necessary square feet of radiation for the house is estimated and then to this twenty-five per cent of it is added to overcome uncovered mains, etc., and twenty per cent more for friction and condensation. The final is used for selecting the size boiler. For this reason most boilers have a sufficient amount of extra capacity to carry an added load over that of the house.

The feed pipe which must be extended from the house to the radiator must be carefully studied out. It cannot be below the water line of the boiler in the house, and yet it must be placed underneath the ground in concrete to prevent it from freezing. The location of tapping the main system and other details require the consideration of an experienced heating man for each particular job. If the garage is located too far from the house it may be absolutely out of the question to make an extension. If the garage is below the house level this may make it impossible. All these factors must be considered. The problem is comparatively simple, however, in most cases. In the average case a one and one-half inch or two inch pipe will be large enough to supply all the steam necessary to the radiator.

HEATING THE GARAGE

A SMALL garage can be heated most economically by means of an oil stove encased in fine mesh gauze, somewhat after the style of a Davy mine lamp. It is impossible for flame to pass either way with this arrangement, and it is therefore very safe and at the same time portable. If cheap gas is at hand, the same method can be used, in this case piping the air to the mixer from outside the building. As a matter of convenience,

a pilot light can be left burning, so as to bring the heater into action without the striking of matches. This latter not only for convenience but for safety. K., Newark, Ohio.

An Externally Housed Coal Stove

Build, either inside or outside of the building and against one of its walls, a small closet (if inside), or addition (if outside), about four feet square. Install in this a coal stove of the size deemed necessary, that has a heater drum attachment, ordinarily used for heating the room above the one in which the stove is located, by a pipe through the ceiling. Next, lead the sheet iron pipe from the hot drum to the inside of the garage by cutting an opening in the partition just large enough for the pipe. The stove pipe may be led to the outside of the building without being exposed to the inside. If the door in this stove compartment is made a good tight fit it may with safety be located inside, but my preference is outside the garage.

The sides of the compartment in closest proximity to the stove may be lined with sheet asbestos; and a small amount of ventilation may be provided at the bottom. The result is a most satisfactory heater that may be left for a day at a time, without fear either of damage or of the fire going out.

FRANK K. GREEN, Salem, New Jersey.

Prefers a Unit Hot Water System

Hot water is the ideal heating medium for the purpose in question. The heater for this purpose should be what is generally termed, by manufacturers and heating contractors, a tank heater. These heaters are too small for ordinary house heating, but can be secured of ample capacity for a small garage. This style heater can be placed in a corner of the garage and takes up little space. The most convenient radiator for this purpose is a regular wall radiator.

This style of radiator is best suited for several reasons: It takes up but very little space, only protruding from the wall about 4 inches. It can be elevated on the wall a sufficient distance above the return inlet to the heater so that an ordinary gravity system may be used and the hot water supply and the cold water return may both be connected at the bottom of the various radiators and thus do away with overhead pipes. Wall radiators can be connected in many different ways so that the proper amount of radiating surface may be had, and yet the radiator can be placed where most convenient.

A tank heater such as mentioned above would cost from $15 up, according to heating capacity desired, while the wall radiators would cost about 25 cents per foot of radiating surface.

WILBUR C. SUNDERLAND, Lincoln, Nebraska.

CHAPTER XIV

HINTS FOR THE TOURIST

TOOLS TO CARRY

DURING the touring season last year the writer came in frequent contact with the automobile travel through Oregon and northern California.

Casual inspection of the equipment of the majority of these motorists would have been interesting to the junk dealer as well as a study for the accessory man. In addition to a full and generous equipment of tools, extra tires, the smaller repair parts and extras ordinarily carried in country driving, many were loaded down with a heavy supply of extra gasoline and lubricating oils, extra springs, large towing ropes, water bags of big capacities, as well as a most elaborate camping equipment, including numerous parcels of personal luggage, large rolls of canvas and blankets, shovels, axes, saws, guns, fishing tackle, lanterns, numerous buckets, pots and pans, and a commissary department that would do justice to a logging camp. It was not out of the ordinary to see a touring car carrying two or three persons loaded beyond safe capacity with "touring preparedness."

Touring may be enjoyed in any part of the United States except the Rocky Mountain desert sections and small portions of the South with very little more equipment than is necessary in ordinary country driving where hard surfaced road is not available.

The present popular use of motor cars has been instrumental in the establishment of more or less competent motor repair service in every city and practically every hamlet in the United States, and even though the motorist may not find in the small hamlet the skill to suit his taste he will find better equipment and generally a better selection of repair parts with which to cure his mechanical troubles himself than he could possibly hope to carry in his car. He will also find these same hamlets well supplied with gasoline, motor oils and many other necessities to motor comfort.

Before embarking on a tour the least extensive the motorist may save himself much grief and enjoy his tour in better

temper by having all mechanical parts of his car in prime condition. All carbon should be removed from the cylinder heads, the valves should seat perfectly and show no pitting whatever. The slightest motor knock should be traced down and remedied. The gasoline line should be cleaned, the circulating system should be flushed out and given an alkali treatment if necessary, the electrical conductors of all circuits should be examined and all connections made tight. Clean and place new lubricant in the crank case, stearing gear, gear set and differential; in fact, start out with a fresh supply of lubricant in all receptacles. Not only try out both brakes, but examine the lining of both and replace any thin lining and thoroughly adjust both brakes. See that all play in steering gear and driving mechanism is remedied. Have a perfectly operating clutch even if refacing has to be resorted to. Test the electrolite in the storage battery and have it charged if it is not already nearly so.

The writer has found that quite extended tours in the Pacific Slope States, including the mountainous sections thereof, may be enjoyed in perfect mechanical satisfaction with the following listed articles:

TOOLS

2 Pair tire chains.
1 Efficient jack.
1 Brace wrench for changing rims.
1 Efficient tire pump.
1 Tire gauge.
1 Valve tool.
1 Small vulcanizer.
1 Sheet fine sand paper.
1 Sheet fine emery cloth.
All special wrenches belonging to car.
2 Monkey wrenches (large and small).
1 Small set socket wrenches adapted to car.
1 Small Stillson wrench.
2 Screw drivers (one with all wooden handle).
1 Pair pliers with wire cutters.
1 Good jack knife.
1 Small vise to clamp to running board.
1 12-oz. machinist's hammer.
1 Punch or carpenter's nail set.
1 Cotter pin extractor.
1 Large flat mill file.
1 Thin knife edged file.

1 Drill.
1 Small short-handled axe.
1 Towing cable.
1 Oil squirt can (carried under hood).
1 Grease gun.
1 Small funnel.
1 Chamois skin.
1 Small ball of marline.
1 Pocket electric flashlight. (If car has no trouble lamp.)
1 Pocket ammeter.

SPARE PARTS & EXTRAS

1 or 2 Extra tire casings and inner tubes.
1 Strong two-gallon can extra gasoline.
1 Strong two-quart sealable can gas engine oil.
1 Can grease.
1 Small sealable can kerosene.
1 Blowout patch.
1 Leather tire sleeve.
1 Package assorted cement patches.
1 Small package raw rubber for vulcanizing.
1 Small can vulcanizing cement.
1 Tube self-vulcanizing cement.
1 Can mastic.
1 Box mica tire powder.
6 or more extra tire valves.
4 Extra valve caps.
4 Extra dust caps.
4 Extra headlight bulbs.
2 Extra tail-light bulbs.
4 to 12 feet good insulated wire.
1 Roll electrician's tape.
½ as many extra spark plugs as motor has cylinders.
½ as many extra porcelains as motor has cylinders.
1 Ball asbestos wicking.
1 Bundle waste.
1 Assortment copper, asbestos and rubber gaskets to fit car.
1 Piece radiator steam hose (18 inches long).
2 Extra hose clips.
2 Extra valve springs.
1 Extra fan belt.
1 Small sheet rubber packing (1/16 inch thick).
1 Assortment cotter pins, nuts, lock washers, wood screws and nails.

EMERGENCY FOOD SUPPLY

(Four People)

2 Two gallon canvas bags water.
4 Pound packages hard tack.
4 Half-pound cans meat or fish.
2 Pounds sweet chocolate.
2 Cans fruit.
Personal luggage.

The extra tire rack, one running board and the regular tool compartment can be made to carry all the above equipment so long as order is maintained in the placing of the articles. Of course, camping equipment may be substituted for the above food supply if camping out is planned upon, but selection of camping equipment should be made with due regard for its bulk and weight with reference to the capacity of the car.

C. M. C., Fort Canby, Wash.

Tools That Have Always Answered

The tool equipment that I am about to outline has been in my car for the past year and I have never found a time that some of the tools didn't play an important part, and I never yet have been stumped when it came to making a repair. For convenience I have divided my tools into three classes, because I have three different places to keep my tools and keep the ones most used in the handiest place.

Nowadays every car has either pockets in the doors, cupboards in the cowl or a pocket between the two front seats. There is also room under one of the front seat cushions and sometimes both, but as a rule one of the front seats is taken up with the storage battery. Some makers don't fix the back seat so it is available, but with a few good boards at hand the average car owner can make a valuable tool carrier under the rear seat.

1. First I'll relate the pocket tools that I carry in a little compartment that divides the front seats.

One pair of adjustable pliers, which are better known as just pliers.

One six-inch crescent wrench, sometimes called adjustable end wrench.

One six-inch pipe wrench.

One ten-inch screw-driver.

One gasoline tank filler cup wrench.

One tire gauge.

I have two small end wrenches that came with the car, and

as they are made especially for this car they are very handy and I carry them in this class.

2. In the second class I carry heavier tools that are quite often used and also necessary tools to make a tire change. I carry these tools under the driver's seat so that he alone is disturbed when any of these tools are needed.

One eight-inch crescent wrench.
One twelve-inch crescent wrench.
One ten-inch pipe wrench.
One four-inch screw-driver for small electrical parts.
One twelve-inch screw-driver.
One light ball-peen hammer with two cold chisels and punch.
One good jock and ling handle.
One tire wrench.
We have an engine-driven pump and carry the hose in this class.
Tire chains.

3. Under the back seat I carry the following tools, which aren't used very often, but are actually necessary.

One hand axe, which can be used for a heavy hammer.
One small pair of tackle blocks, with seventy-five feet of rope.
Two special rim tools or pegs for changing the tire on the rim.
One bulb case, with bulbs for the car's lamps.
One hand-tire pump in case motor-driven pump fails.
Several special wrenches, such as hub-cap wrench, spanner wrench and socket wrench.
Some other tools for towing might be added here, as they play an important part.
One swivel searchlight for illumination when repairing parts.

In one of the pockets I carry a route book, with rubber bands separating the different pages that contain the route I desire to travel.

I also carry a pair of canvas gloves in one of the pockets; these I wear when I have to change a tire. Under the back seat I have a pair of rubbers and an old rain coat, which come in handy when it is necessary to put the chains on in the mud.

Of course, I always carry two tires on the rack, all inflated, and two extra inner tubes under the rear seat, as well as a couple of blowout patches and some extra spark plugs.

The above equipment might sound cumbersome, but you

will find that it is very easily stored in the various compartments which I have mentioned, and that you will never regret any one tool of it.

NEIL E. ENSWORTH, Warren, Pa.

MOTOR CAMPING EQUIPMENT

CAR camping may be either a most enjoyable experience, or the sorriest of wet-blanket routes. That depends. Several successful voyages "into the bush," and one or two incidents of actual suffering, have taught me the wisdom of the following equipment and advice:

1. Don't venture forth without a first-aid and emergency kit containing bandages, cotton, antiseptic, adhesive tape, scissors, safety pins, needles, and thread.

2. Take along a hand lantern, preferably of the mantle type generating its own vapor from gasoline; also a compass, maps, rope, a light ax, and a "boy's size" spade. A canvas water-bag has unique merits.

3. Include in your outfit these utensils of aluminum: kettle, skillet, stew-pan, covered baking pan (as oven), coffee pot, salt and pepper shakers, dipper, basins, nesting cups, and a dozen pie-plates (or several dozen wooden plates); also long fork, long spoon, wide-bladed kitchen knife, can opener, etc., and a generous supply of absorbent paper napkins.

For cook's sake, provide a folding stool; and a jointed grid to set up over the fire. The latter eliminates makeshifts—and spills—besides being an excellent broiler and toaster, "Old timers" hereabout, who should know, purchase these grids—in fact, their kompleat kamp kook kits, duffle bags, etc.—and insist on their undoubted value.

Some car campers may not be aware that the windshield, folded inward horizontally, makes a serviceable quick-lunch counter.

4. Like many tourists in this region, I have obtained extra luggage space thus: Run two rods of small angle-iron from fender to fender, a foot or more apart, above and parallel to the outer edge of one running board. Bore holes in the rod ends and fender flanges, and fasten with bolts, four in all. They are quickly removable and leave no trace.

5. As regards sleeping arrangements, there is one expedient so superior to any other that the failure of car-body designers to take the hint is a standing mystery. Personally, I object to retiring up among the top-bows of my car *via* the stepladder route. I, accordingly, got an upholsterer to alter the back of the front

seat so that, when released at the sides, it swings backward level with the tonneau seat. Nickeled refrigerator-door clasps and hinges insure a neat job. At sleeping time the rear cushion is reversed, and lo! a deep wide bed and soft mattress, without cumbersome lugalongs. A canvas stretched from the raised top to the ground and a folding cot beneath doubles accommodations.

6. The kind and amount of protective coverings to carry must depend on the prevailing climate. In any case, don't decide that it won't rain. And be prepared against chilly nights. Cold feet, actual, are mostly to blame for the corresponding mental attitude toward camping. Blue morning faces are really unnecessary. Remember that you have a radiator aboard—an efficient water heater. Run the engine a bit and draw off into bottles for the bed-warming comfort of all.

ALBERT B. TRIPP, Tacoma, Wash.

Existence and Economy or Luxury and Expense

I spent six winters of my life as a trapper and the camping outfit was no larger or heavier than one could pack on his back. As I recall those days now they seem to me that that was "Existence and Economy," and as I think of some of our millionaire sportsmen, we can class their outfits as "Luxury and Expense." Now somewhere between those extremes there is a condition of comfort at a reasonable cost. I say comfort because you cannot enjoy your trip if you do not sleep well, keep dry and have a convenient way of cooking.

The last few seasons, I, like so many others, have but two weeks' vacation, all of which has been used for a simple trip and I find that without a real stove and bed I get so tired that two weeks seem long enough. It seems only natural to let our fishing or shooting infringe on the time we would be cooking or sleeping.

As this magazine is distributed through all States of the Union and some other countries, it would seem unreasonable that a camping outfit for Minnesota or Wisconsin woudl be just the thing for California or Florida or vice versa.

Here is the outfit I use and some of the reasons for selecting it:

I have a nine-foot square wall tent made of twelve-ounce double-filled canvas. This tent is practically waterproof and will remain so as no preparation or waterproofing has been used on it. Waterproofing is all right for a season or two, but is liable to rot the canvas. The tent is arranged so it may be set up on poles or swing from a ridge rope when in the woods and is of ample size to accommodate three folding army cots. An eight-ounce tent with a fly will turn as much water, is warmer in cold weather and cooler in hot weather, but necessitates the extra

stakes, ropes, etc., and requires a lot of extra labor if moved often.

For beds and bedding we use three folding army cots. These cots fold up easily and in a small space. They are more comfortable and healthful than sleeping on the ground. Take plenty of comforters and blankets, for you will need as many under you as over.

We have two stoves, a sheet iron folding affair that burns wood, and a two-burner gasoline stove, either of which fold up smaller than a suit case. We carry our dishes in one suit case and eatables in another. Also have three folding camp stools. The first trip we carried everything inside of the automobile, but later found most of it could be carried on the running boards, but must be well tied on.

This year I am building a folding boat that will be carried on a trailer. One-half of the boat will act as a box, while the other half as a cover for same.

If your car is new or many are going on the trip, I would advise using a trailer, as they save the finish and cushions.

There are some trailers on the market that include a complete camping outfit; in fact, they are a cross between a house and a tent that folds up, beds, bedding, stove, and all, into a trailer; the only objection is the price, $250. Here are a few camping "don'ts" that may help you on the way:

Don't overload with "useful" things, just take necessities.

Don't try to own the land you are camping on. You might meet the man who has the deed.

Don't go away and leave a fire burning.

Don't take any more game or fish than you can use.

Be friendly with the farmers and your trip won't cost you as much, and you will be welcome next year.

M. A. Wright, St. Paul, Minn.

Care of the Car

Ford Section

While much of the general information in the preceding pages is of value to owners of Ford cars, there is so much specific data which Ford owners require that it has been found advisable to devote an entire section to it.

CHAPTER XV

THE FORD IGNITION SYSTEM

IMPROVING THE IGNITION SYSTEM

THE two troubles that are most common with the Ford four coil system of ignition are: the burning of the vibrator points, and the lack of synchronism.

Due to the variable voltage and the excessive amperage generated by the Ford magneto at high engine speeds, there is a great tendency for the platinum vibrator points to pit or burn unevenly, causing them to stick together, and so reduce the efficiency of the coil, or cause it to stop its action entirely. This effect is very noticeable upon a car that is used a great deal during the day and does not have the lamps to use up the surplus current.

In every coil there is a certain amount of magnetic lag; by this I mean that the vibrator tongue hesitates just a small fraction of a second before it responds to the current passing through the coil. The time of this lag, that is, the time elapsing between the turning on of the current and the action of the secondary spark will vary in coils for two reasons. Every coil contains a slightly different amount of iron in the core, amounting it is true to but the smallest fracton of an ounce but enough to make a difference in the speed of the magnetic lines of force. It would be almost impossible to have all of the vibrator tongues of the same springiness or tension. In addition to this the lengths of wire used in the windings may vary a few inches in each coil.

These conditions in the four coil system of the Ford result in lack of synchronism:—that is, the spark at the four plugs does not take place at exactly the same position of the piston, even though the contact is made at the timer at exactly the same piston position.

When the coils are not absolutely synchronous the engine will lack power to a certain extent.

To overcome both of these troubles I have installed a master vibrator. By this means, there is absolute synchronism and the replacement of platinum contact points is cut down from four to one. The adjustment of the vibrator points is much easier when one coil is used, and a hot spark is assured for all cylinders.

You can see very easily that when a master vibrator is installed, all of the objectons to a four-coil system have been removed, in reality you have made a single coil system of it.

W. S. Winslow, Providence, R. I.

Minor Troubles Rather Than Inherent Defects

The common troubles which arise from the four-coil ignition system as installed on the Ford car are due largely to the multiplication of parts rather than to any inherent defects in the system itself.

The four coils, placed as they are, on the dash to protect them and make them accessible, necessitate a somewhat complicated system of wiring. My greatest trouble with this system has been caused by the wires from the coils to the commutator becoming chafed or oil soaked. If, however, these wires are renewed occasionally they will cause very little trouble.

Another rather frequent cause of trouble with this system is with the vibrators on the coil units. After any considerable use the contact points on these vibrators become worn and frequently become roughened so that they stick together, causing uneven running of the engine. While this roughening of the contact points causes the engine to run unevenly, still all uneven running of the engine does not arise from this source, as many inexperienced drivers presume. Many a good series of vibrators are ruined by constant tinkering, when as a matter of fact the trouble lies with a faulty spark plug or a poor contact on the commutator. The vibrator adjustments should not be tampered with except as an extreme measure.

Another source of trouble with the four-coil system, especially with the 1917 model, is the short circuiting of the system caused by water leaking into or behind the coil box. This may be remedied by loosening the dashboard and placing behind it a strip of felt which has been soaked in shellac. When the dash is tightened the gasket will then make a waterproof seal and prevent rain from leaking down behind the coil box.

Generally speaking, however, the Ford ignition system is very efficient, and if not tampered with except when absolutely necessary will prove very satisfactory under all ordinary conditions.

Hamilton A. Hooper, Eagles Mere, Pa.

Proper Adjustment and Attention Needed

The Ford four-coil ignition system has been the subject of much unfavorable comment. The new Ford owner is often suddenly awakened to the fact that his motor has commenced to miss, and having heard so much about the inefficiency of the coils,

he immediately decides that his motor needs an ignition system which will deliver an even hot spark.

There are three well-known substitutes for the four-coil vibrator system: the master vibrator, which still retains the coils and commutator, but eliminates the four vibrators; the magneto, which dispenses with the use of the Ford magneto current, the coils and the commutator; and the unit coil with the single vibrator, also dispensing with the entire original Ford equipment.

The master vibrator may be installed at a nominal price. By this system the coils and commutator are retained, but the four vibrators are shunted to a single vibrating coil. When properly adjusted this coil renders very satisfactory service, but when the vibrator becomes pitted, it often sticks and a temporary short circuit requiring a great deal of coaxing to come to life. Where cost is not considered and where high speed is desired, the magneto is very desirable.

The unit coil with the single vibrator, taking the place of the four coils, the commutator, and dispensing with the magneto current is a popular substitute, and one which may be installed at a reasonable first cost. This system uses dry cell instead of current from the magneto, and it is very efficient when the cells are of high test, but when they become reduced after a few months' usage, the current is weakened, and an insufficient spark and very hard starting is the result. The after cost of such a system should also be considered, because new batteries must be purchased every two or three thousand miles.

When all has been said of the substitutes for the four-coil system, one should realize that this system can also be improved, and a substitute is not needed. It should be noted that the recent coils are not so troublesome as those which were used a few years ago. The vibrators last longer, do not stick so easily and produce a hotter spark. With proper adjustment and care these coils should produce satisfactory current, and the Ford motor and magneto were originally intended to be used in connection with such a system. If the vibrator points are kept the proper distance apart, the surfaces kept clean and smooth, and the commutator properly oiled and cleaned, the ignition system will give no trouble and will be the most satisfactory system for the Ford motor. Inspect the commutator roller often and if it becomes worn, install a new one. This is often a source of unsuspected trouble and the blame is laid to the coils.

H. W. A., Washington, D. C.

CHAPTER XVI

THE CARBURETION SYSTEM

IMPROVING THE CARBURETION SYSTEM

THE following home-made device which was designed to increase the efficiency of the carburetion system on Ford cars has been in use on the writer's car about six months and the results obtained fully justify the time and money expended. The device consists of a valve on the intake manifold and a means for readily opening and closing the valve.

The materials needed are inexpensive and for the most part can be found in any garage or home workshop.

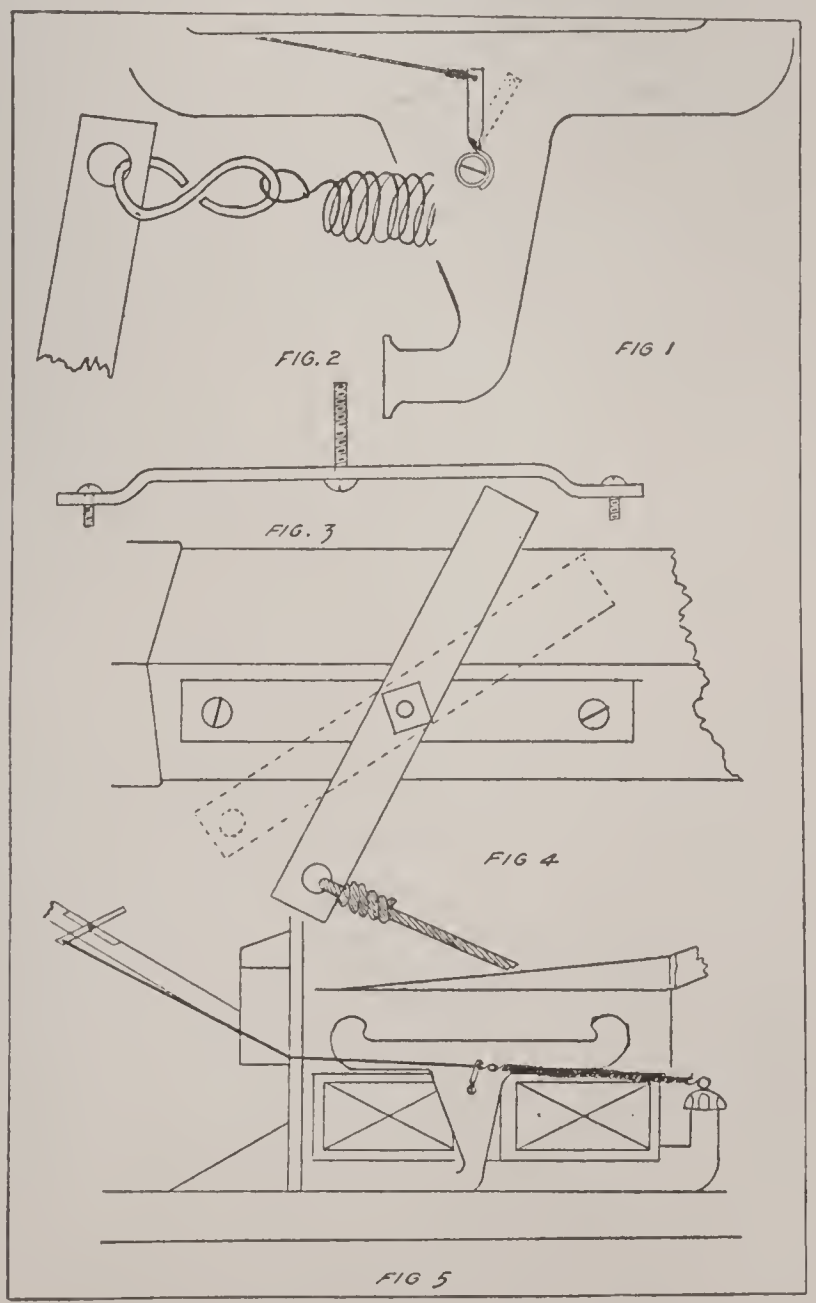
To install the device, proceed as follows: Procure a brass oil cup with a ⅛-inch pipe thread. To this should be soldered a piece of brass 1 1/16 inch thick, ⅜ inch wide and 2¾ inches long, shaped and drilled as shown in Fig. 1. The intake manifold should now be removed from the motor and tapped about 2½ inches from the top with a ⅛-inch pipe thread and the oil cup inserted as in Fig. 1. The opening should face the dash and should be entirely open when the arm, soldered to the cup, is in the position designated by the dotted lines (Fig. 1).

Next procure a light spiral spring, the kind commonly used in shade rollers being of the proper tension. Use the full length of the spring and with a pair of pliers fashion a loop at each end. Make two S hooks of stout wire and insert a hook in the loop at each end of the spring. One end of the spring should then be hooked to the arm on the oil cup and the other end to the adjusting bolt on the fan bracket. The S hooks should be squeezed together to prevent their jarring off on account of vibration (Fig. 2).

As the purpose of the spring is to keep the air valve open, some means of closing the valve, when desired, must be used. This is accomplished by a lever on the steering post directly below the wheel. A copper bar ⅛ inch thick, ½ inch wide and 5½ inches long was bent into the shape shown in Fig. 3. Three holes should be drilled, one at each end and one at the center. Lay this piece on the upper side of the steering post directly below the wheel, and after marking the location of the two end holes, drill, tap and fasten this piece to the center hole, facing up (Fig. 3). Another piece of copper bar of

the same dimensions should be drilled, placing one hole 3/8 inch from the end and another hole 2¾ inches from the end. Place this piece over the one shown in Fig. 3, the center hole fitting over the machine screw. Over this put a small spiral spring and a nut. Screw down the nut until the tension is strong enough to hold the lever in any position, then rivet the end of the machine screw to prevent the nut from coming off (Fig. 4).

The final step is to connect the lever and the air valve by a small flexible cable, such as that used on muffler cut-outs, running through a hole in the dash to the right of the coil box. The



air valve should be closed when the lever is in the position shown by dotted line in Fig. 4.

Although some slight adjustments may be necessary in order to secure a satisfactory operation of the device, the air valve is now ready for use. The operation is as follows: Have the valve closed when cranking the car or difficulty will be experienced in starting. After the car has attained a speed of fifteen miles per hour, slowly open the air valve. The car will now pick up to about eighteen miles per hour, when the throttle can be shut down to bring the car down to fifteen miles per hour again if desired. You are now using less gasoline and more air, still the speed is the same as before. As the speed of the car increases, the amount of air to be admitted can be greater, but the air valve should not be opened to such an extent as to cause the motor to buck.

The use of this appliance will show an increase in gasoline mileage from three to six miles or a corresponding increase in speed if desired. After being installed on a Ford, the maximum speed was increased from forty-two to forty-eight miles per hour.

In addition to its use as a gasoline saver, I have used it to keep the motor free from carbon in the following way: Speed up the motor, open the air valve and by holding an oil can filled with water, inverted, at the opening of the air valve, the water will be drawn into the motor and converted into steam. Using a pint of water in this way every 300 miles will do much to reduce trouble from carbon deposits. Kerosene oil can be substituted for water with beneficial results.

J. Adam Palm, Mt. Vernon, N. Y.

The Value of Extra Heat

MY first attempt at improving the efficiency of the Ford carburetion system was to install on the intake manifold, just before it divides, an auxiliary air valve controlled by a wire leading to the steering post. This device was not very successful in my case, as it gave the car a tendency to "buck," especially at low speeds.

I next tried a home-made device consisting of a small copper pipe attached at one end to the hole in the intake manifold made for the first air valve. The pipe was carried up and laid along the exhaust manifold and ended in an old gas shut off on the engine side of the dash. The handle of the valve was put through a hole in the dash so that it could be within reach of the driver. This device supplied hot air to the mixture and was much more successful than the first device. I have also found it very convenient for inserting small amounts of graphite into the engine cylinders occasionally to improve the compression.

My next attempt was the purchase of a widely advertised device consisting of an automatically operated damper placed in the air intake pipe to the carburetor. This gives a rich mixture at low engine speeds and a leaner one at high speeds. This device gave me about 15 per cent more mileage per gallon of gas and greatly increased the flexbility of the car. My home-made auxiliary device did not work as well after the installation of this apparatus, due probably to the mixture being pretty weak anyway.

My latest scheme is to fill the space between the exhaust and intake manifolds with scraps of fine copper wire packed in as solidly as possible, and held in place by a piece of sheet iron bent around the exhaust manifold and clamped under the manifold clamps. This conducts the heat from the exhaust to the intake manifold, thus helping to vaporize the gases passing to the cylinders. I can now run with a somewhat weaker mixture than before and can use the auxiliary air also. On a recent trip of 190 miles, about sixty of which was through mud so that chains had to be used, I made better than twenty-four miles to the gallon and no special effort was made to get a record. No one could ask more, even from the economical Ford.

C. D. K., Worcester, Mass.

CHAPTER XVII

THE LIGHTING SYSTEM

IMPROVING FORD LIGHTING

AT a speed of twenty miles an hour or over the headlight equipment of the Ford illuminates the road with startling effect; at ten miles and under, without the assistance of some additional device, the head lamps become hopelessly inefficient. The reason being, of course, that the current flow to the lamps varies with the speed at which the fly wheel magneto revolves.

My first effort to increase their efficiency was to connect some eight dry batteries in series and install a two-way switch. This served more effectively than the magneto where in driving through difficult stretches the low speed gear was often used, and when on changing from low speed to high the current flow was so greatly reduced that one experienced the sense of blindness, similar to passing from a lighted room into the darkness, as the intensity of the lighting was so changed with the change in speed gearing.

While the dry battery illumination was complete and lacked the fluctuating disposition of magneto current, yet I soon found that the cost was not proportionate with the service.

After investigating several devices and obtaining advice from other Ford owners, experiencing similar difficulties, the equipment adopted consists of two 6-7 volt, twenty-one candlepower nitrogen filled bulbs and an inexpensive, yet very efficient lighting control or switch which contains a choking coil and has steps or positions for changing the intensity of the current flow. The switch is mounted under the wheel on the steering column, within easy reach of the hand and supplies, addition to illumination, a means of returning a courtesy which the majority of motorists extend, that of dimming the head lamps while passing at night.

The illumination at all times is superior to the direct lighted higher voltage bulbs formerly used, and the difficult stretches are more easily negotiated than with the previous equipment.

After six months' use the bulbs or switch have neither burned out nor been replaced and the few dollars expended in the equipment are amply repaid in the satisfaction and comfort experienced, both with the intensive illuminating service and the

ability to dim the lamps on occasions, particularly while passing others at night.

G. A. L., Washington, D. C.

More Light, I Say

To get enough light at low motor speeds, and yet not burn out the bulbs at high speeds, are the horns of the dilemma upon which the Ford lighting system is often hung. Then, too, it must not take too much current, or it will interfere with the ignition.

The simplest plan I found was a switch and a wire, connected to the wire between the two headlights. When the switch was turned on the full force of the current was concentrated through one headlight. I tried this plan for a week, but ran the motor a little too fast one night and burned out one headlight bulb. To get home, I transferred the other bulb to that same headlight, but had to drive many miles at a painfully slow rate of speed to keep from burning out the remaining bulb. Then I removed the wire and switch, for the system required too much trouble to operate and was too apt to burn out bulbs.

The second plan was based on the idea of burning the two bulbs in parallel, at low motor speeds. To change the connections from series to parallel, I used a two-point double throw, or reversing, switch. As I had found manual control too much trouble and unreliable, I mounted this switch on an L-shaped iron strip, between the carburetor and the radiator. A piece of stiff piano wire was used to connect this switch with the throttle arm, so as to move the switch from parallel, at slow speeds, to series at higher motor speeds.

This system worked pretty well, although there was a decided jump in the brilliancy of the lights, when the connection was changed from series to parallel. Also, there was a dark gap on the throttle. That is, the two notches between the series and parallel connection could not be used at night, as the lights would go out. I burned out one pair of bulbs by driving too fast down hill, with the clutch engaged and the throttle almost closed. After that, I always disengaged the clutch, and nearly closed the throttle, when descending grades. This gave a good light and tended to save gasoline. This system has had an advantage over the first system, in that both headlights are always used, thus complying wth the law, and safety first. When only one headlight is used, the driver of an approaching car may think it is a motor cycle and not allow enough of the road.

My next adventure in headlight experiments was to install a small transformer, with the headlights connected in parallel. I only used this for a short time, as I had one of the older types of Ford magneto on my car, and the transformer took so much

current that it did not leave enough for ignition on hard pulls on high gear. However, if my car had been fitted with a 1916, or later, Ford magneto, having three-quarter inch magnets, I think the transformer might have been a success, as these late magnetos give much more current than those of earlier date. The transformer necessarily takes more current, as some power must be wasted in transforming the current from one voltage to another, but the light is more uniform, because the inductive effect of the transformer coils tends to prevent the current at high speeds from becoming excessive.

But the system that I now use consists of two fourteen-volt, twenty-one candlepower, nitrogen filled bulbs connected in parallel. While these nitrogen bulbs are more expensive, retailing at from seventy-five cents to a dollar, they are so much more efficient that they actually consume less current than the fifteen candlepower bulbs, with which the Ford is usually supplied. As these bulbs are of only fourteen volts, they burn brightly, even at low motor speeds. The self regulating quality of these bulbs tends to protect them at high motor speeds.

For city use, I have added a little convenience in the form of an electric tail light and dimmer. The tail lamp bulb is of about the same amperage as that of the two headlight bulbs connected in parallel. And this tail lamp is connected in series with the headlight circuit. When the switch is opened, the tail lamp is turned on, and the amount of current taken by the tail lamp dims the headlight bulbs to comply with city ordinances.

MURRAY FAHNESTOCK, Pittsburgh, Pa.

CHAPTER XVIII

THE LUBRICATION SYSTEM

LUBRICATION TROUBLES WITH THE FORD

AFTER breaking in my Ford I felt that there was but one thing wrong with the whole car—it was an "oil gusher." I could not run over two hundred miles before the spark plugs were too dirty to fire properly, particularly number one. After each fifteen hundred miles the job of removing carbon and grinding valves was necessary.

But number one cylinder was my greatest worry. I put oversize rings in it, but that seemed to help little. I thought my car was peculiar in this fault, but inquiry among Ford owners showed that most of them had trouble with the same number one spark plug fouling quicker than any of the others.

The Ford splash oiling system is arranged to give ample lubrication to the front cylinder in hill climbing, but this system frequently over-lubricates on level running. To remedy this trouble I removed the lower crank case cover which has the connecting rod oil "dips" pressed into it, cut a piece of wood to fit the back half of the front dip, laid it bottom up on a flat bench, and with a hammer mashed in the front dip about one-sixteenth inch from the center to the extreme front, and then replaced cover. The piece of wood was, of course, removed, having been put there merely to prevent the back half of the dip from going down with the front. This caused number one connecting rod to dip or splash into a smaller quantity of oil when running on a level without affecting the supply in hill climbing, as on a grade the front half of the depression holds practically no oil, since oil, like water, seeks its level. This has the desired effect of making the oil supply to the different cylinders more uniform, but it was uniformly too much. Varying the grade of oil and the oil level in the engine was practically no help.

I then decided to test the fitting of the pistons in the cylinders, so removed the motor head and lower crank case cover, and removed the pistons. With an accurate inside caliper and a pair of dividers (which I borrowed) I proceeded to measure the cylinder bore and piston diameters. I found that the cylinders varied .003″, the pistons .004″, and the piston clearance varied more than that, and since I had read two authorities who agreed that "the proper clearance between the skirt of an iron piston and the cylinder is .003″," I felt that I had found the trouble.

I took careful measurements for the four cylinders, and with the

calipers and dividers selected four pistons from the large stock of a local Ford agency that had an exact clearance of .003″ for each cylinder, and marked the number on each piston. I then fitted these pistons with good compression proof rings in place of the regular diagonal rings furnished and replaced the pistons in the motor.

The result is a sweet running motor, with plenty of pep and power, plugs that look clean after 500 miles, and a motor that needs decarbonizing and valve grinding only after a season's use.

J. S. G., Richmond, Va.

Correct Lubrication Means Conservation

QUITE in line with the nation's plan of conserving comes the queston of economical upkeep of the Ford.

In the Ford engine there are many parts moving simultaneously which are constantly covered with a thin film of oil, the oil taking the wear instead of the metal. Repair men universally agree that 50 per cent of all engine troubles are directly traced to improper or insufficient lubrication, the most common of these being scored cylinders, worn pistons, rings, bearings, etc.

At the end of the year, say perhaps that 15 per cent of your upkeep is checked against lubrication. Surely this is your smallest expense and herein lines the secret of economical upkeep.

The writer has had considerable trouble with his Ford by having oil leak constantly past the piston rings into the combustion chambers. Several repair men failed to stop defect, so the writer took the engine down himself and bevelled the outside of each top ring with a file. The result of this filing, allowing the ring to ride over the oil on the cylinder walls on the upstroke and on the downstroke the square edge of the ring would scrape the oil down.

The Ford owner who has run his car several years will find that the use of a heavier body of oil will give a better delivery of power, caused by making the various parts fit more tightly, thus aiding compression.

Castor oil used in the timer will not gum up the rollers as easily as a heavier oil.

The oil in the crank case should not be permitted to run freely from the top petcock. If this should drip sparingly there is enough oil to let the engine work at its best.

For filling the grease cups, the best grease one can use is cup grease. There are six grease cups on the Ford. The two on the universal joint and the front end of the driveshaft housing are the most important and, too, are the most difficult to reach as removal of the floor boards is necessary. When a grease cup is empty, this fact is easily ascertained by the fact that the cap cannot be screwed down further. Fill each cap, force it all the way

down and take off and refill again as in this way you are assured that the lubricant is being properly fed to the wearing surface.

The Ford axle has a nasty trick of throwing grease around the hub brakes. This can be overcome by installing new washers in the axles. Bear in mind that a little and often is the best idea in lubrication. The rear axle housing must have just enough grease for the bevel gear to dip into and not more than this for here is the reason why grease flows from the ends of the axle.

Each Ford owner has his own ideas as to the upkeep of his engine, but many owners fail to locate troubles because they take only a limited view of the problem. A little thought and a diagnosis of each particular trouble as it appears, studying it thoroughly before it advances into more complications, will prevent many of the ailments of the Ford and tend to make its owner proud of the fact that he knows and understands the "insides" of the best little car in the world.

FREDERICK GILMAN JOPP, Edgewood, R. I.

Fool Proof for Wise Men

While the Ford oiling system is often described as "fool-proof," it is my experience that not all Ford drivers are fools, and a more complete oiling system would be a boon to a great many Ford owners.

Perhaps the most complained of feature of the Ford oiling system is the location of the "try-cocks" which form the only sure means of determining the oil level. A gauge glass is sometimes installed in place of the lower pet cock, but it is liable to get dirty or clogged, or it may be broken by flying stones, with disastrous results. I have found it much better and safer to use a long handled wrench to open the oil cocks. This obviates crawling under the car. Such a wrench can be purchased from any accessory store.

Frequent fouling of the spark plugs, particularly number one, on some Fords is usually blamed on the oiling system. This annoying trouble may be caused by using too much oil or the wrong kind of oil, or it may be due to worn pistons or rings or a scored cylinder; or in an old car to settling of the front spring which, of course, lowers the front end of the car and increases the head of oil under number one cylinder. My car had an apparently incurable case of dirty plugs in the front cylinder until I hit upon the expedient of drilling a 3/32" hole in the side of the cylinder oil return pipe opposite the second cylinder. This allowed a portion of the oil to escape without passing under number one cylinder, and reduced the amount of oil in the front of the motor to just the right extent.

"WOLVERINE," Detroit, Mich.

CHAPTER XIX

CONNECTING ROD BEARINGS

ADJUSTING CONNECTING ROD BEARINGS

AFTER many sad experiences, I have developed a system for adjusting the connecting rod bearings of the Ford car which, I think, will eliminate most of the difficulties the amateur repair man is liable to stumble over. Owing to the conditions at hand there is not a great deal of room for originality, the chief requisite being patience and perseverance.

Assuming that the repair man is to work alone, the procedure is as follows:

Drain the oil from the crankcase and refill it with one gallon of kerosene, race the engine under its own power for about ten seconds and drain off the kerosene. The object of this is twofold: to give the mechanism a cleansing bath and to thin down the oil which clings to the internal parts, so that it will drain off rapidly and not continually drip in the operator's face and run up his sleeve while he lies under the car.

To perform this operation it is not necessary to remove the cylinder head, but the spark plugs should be taken out to relieve the engine of compression. It will also be found that time can be saved on the whole job by removing the front radius rods of what it commonly known as the wishbone and work will be much simplified, but this is not necessary.

After blocking the rear wheels, place a jack under the central portion of the front axle and raise the front wheels a few inches off the ground, this will give more headroom underneath the car. For his further comfort the operator should provide himself with a block of wood about six inches high for a head rest while under the car, as this will relieve the neck muscles from a great deal of strain.

The next operation is to remove the handhole cover from the bottom of the crankcase and wipe off any surplus oil which would drip from the crankshaft and connecting rods.

Before going further I will say that the only special tool which it is advisable to have for this job is one of the double angled offset socket wrenches which are made particularly for Ford connecting rods and which is practically necessary for No. 4 rod. They can be gotten at almost any supply house.

Now it is necessary to loosen all the connecting rod caps, but do not remove them, merely back the nuts off a few turns after first extracting the cotter pins. While doing this it will be found necessary to turn the crankshaft over occasionally, and this can be accomplished by reaching overhead and turning the crank handle without getting out from under the car.

Warning No. 1.—Keep the other hand out of the crankcase while turning the engine over. On one occasion the writer howled lustily for fifteen minutes, during which time his finger was jammed between a connecting rod and the camshaft, and he was unable to reverse the direction of the crankshaft and release the finger. It is just as well to advise here that a short pinch-bar is a handy tool to reverse the rotation of the crankshaft when necessary.

Now take a center punch and mark the right hand side of all the connecting rod caps, so that after removal they may be replaced in their previous relative position. Take off No. 1 cap and remove the bolts. What I here say regarding bolts applies to all connecting rod bolts, especially No. 4 connecting rod. Put one of the bolts in a vise, stem up, and with a wrench run the nut up and down on the thread until it runs freely enough to be turned with the fingers the full length of the thread easily. This will minimize the use of a wrench when replacing the caps. With a three cornered file make a groove on the end of the bolt in line with the cotter-pin holes. This will make it easy to line up the castellated nut when it is necessary to replace the cotter-pins.

If the engine is comparatively new and not badly worn it may only be necessary to remove the paper shims from the ends of the connecting rod caps, but if badly worn it will be necessary to file the ends in order to bring the bearing surfaces closer together. This is done by placing the cap in a vise and filing across both ends with a flat file and a slow, even stroke. Six or eight strokes should be enough if the bearing is not badly worn. In any case, put a few drops of oil on the bearing, replace the cap and tighten up the nuts. Now try turning the engine over by the crank handle, notice how it drags. There should be a perceptible resistance if the bearing is up properly, if not the caps should be removed and filed again.

Warning No. 2.—Do not file off too much without a trial. Should the cap become too tight, so that great resistance is felt at the crank handle, make a few paper shims and place on the cap ends. Place an equal number of shims on either side always. After a proper fit is obtained, back the nuts off until the bearing turns freely and proceed with No. 2 connecting rod. Repeat the process with No. 3 and No. 4, being sure that only one cap is tight at a time.

Warning No. 3.—While the caps are off the connecting rods be very careful not to let the piston slip down below the bottom of the stroke, as the lower piston ring would come below the bottom of the cylinder walls and expand, making a difficult job to replace it, also if the piston is pushed too far up in the cylinder the top ring will expand and make it necessary to remove the cylinder head to replace it. While working on No. 4 cap it may facilitate matters a little to remove the cap of No. 3 connecting rod and push the piston into the upper part of the cylinder, be careful not to go too far, however, and always replace it before turning the engine over. It is to be remembered that while working on any one bearing the other three are to be loose or else the proper resistance will not be noted at the crank handle. After all bearings are fitted tighten up the nuts and replace the cotter-pins. Now the file marks on the bolt ends will be appreciated.

When all external parts are replaced and nine pints of fresh oil are in the crankcase it may be found that the operator is unable to crank the engine due to the tight bearings. Don't let that frighten you, just get your next door neighbor to bring his Flivver around and give you a tow down the street. As soon as the oil works into the bearings, you will find that the engine works as well as before, minus that annoying connecting rod knock.

LEWIS A. MORRISON, Yonkers, N. Y.

Make Yourself Comfortable

The best way I have found to fit the fourth connecting rod bearing on Ford motors is as follows: If you have no pit in your garage run the car up on to an elecator high enough to enable the mechanic to sit under the car with his back towards the front axle. Do not risk ropes or chain hoist to hang car on, or block rear wheels. Hoist car in front about three feet and put strong boxes under the front wheels. This permits the mechanic to sit on a box for working and is desirable because of the comfort and freedom afforded for the slow and tedious work of removing and replacing the nuts and caps. Next you dis connect the ball socket end of the front radius rod by removing the two nuts and cap. This will allow the end to spring down, and the movement of the hands will be unobstructed while adjusting. Next remove the crankcase lower cover and place a piece of cheese cloth or rag into the opening, between the crankcase and the magneto coil support to prevent nuts or cotter pins. which are likely to be dropped, from going into the oil reservoir and necessitating the disassembling of the motor for their removal. It is not necessary to take the cylinder head off. If you remove the spark plugs you can turn the

crankshaft easily. Assuming that the other connecting rod bearings are adjusted, loosen Nos. 1 and 2, so they do not bind on crankshaft, and remove cap on No. 3 entirely; do not replace until work on the fourth is complete. Always loosen the bearing when complete, then you can easily tell when they have the same tension when adjusting. A ten-inch monkey wrench can be used to advantage to turn the crankshaft under the car to bring the offset ends to a position about 2½ inches to 3 inches from the crankcase opening. Then with your hand you can feel the play by pushing it up and down on connecting rod. Also in that position an "L" socket wrench will enter in between the crankcase and the cap. By turning the crankcase to the opposite side in a like position the other nut can be disconnected. With proper care and attention one, as a rule, can make it right the first time, provided the bearing is not worn too much. You don't have to take it off more than once if you use a little judgment. The position of the rod caps on the shaft are indicated by notches filed on the side towards the camshaft and should be replaced in the same position. It is never well to adjust too closely, as some play is needed for an oil film. If the metal is forced into contact the surfaces will abrade and the babbitt cut quickly. When done adjusting, draw all nuts tight and lock with cotter pins. Before replacing the crankcase lower cover, remove cheese cloth from oil reservoir, which, if forgotten, is liable to clog the pipe that carries oil to front of crankcase and bring out front bearings.

HARRY A. DERSTINE,
Quakertown, Pa.

CHAPTER XX

THE COOLING SYSTEM

CAUSES AND CURES OF OVERHEATING

ASIDE from an occasional mechanical defect, such as will sometimes appear in even the most carefully manufactured article, there is but one real cause of a Ford overheating—the driver.

The engine and the lubricating and cooling systems have been carefully designed to maintain the most efficient engine temperature under average working conditions, and with proper care and operation will do so indefinitely.

Good engineering will not permit of an "oversize cooling system," for if such were used the motor would frequently run at a lower temperature than would be consistent with fuel economy.

Therefore the margin between the normal running temperature of the cooling water and its boiling point of 212° Fahrenheit is left just large enough to absorb the extra heat occasioned by a series of sharp inclines or a hard pull through heavy roads and is not elastic enough to cover the hard usage to which many ignorant or careless owners subject their cars.

But two things are necessary to keep the engine from overheating. The first of these is the proper maintenance of its cooling and lubrication systems, together with any needed adjustments to the motor itself, and the second is the use of proper care in driving.

The Ford cooling system depends upon but three things —these being the passage of air through the radiator, the circulation of the cooling water through the radiator and water jackets, and the conduction of the heat through the walls of the radiator tubes.

But it takes a little care and effort to keep these three component parts at their proper efficiency.

To insure the free circulation of air through the radiator openings, the dirt which is continually collecting there should be frequently removed with a hose from the back of the radiator; the fan belt should be kept tight and free

from oil, and the fan bearing should be occasionally oiled, so that it will turn easily. And sometimes the fan blades can be so bent as to increase the volume of air moved by them.

In order to maintain a good water circulation the radiator should be kept well filled, as a thermo-syphon system will stop circulating as soon as the water level falls below the radiator inlet. A frayed and leaking hose should be replaced at once, and the radiator watched for signs of leaky tubes.

The cooling water should be changed about once a week, the best way of doing this being to open the drain and allow fresh water to run through the system for several minutes. This will tend to remove any incrustation which may be adhering to the walls of either the radiator or the water jackets, and in this way preventing the free conduction of the heat.

The softer the water the less scale will form, but any water used, even rain-water, should be strained.

In localities where very hard water must be used, an occasional washing out with a lye solution consisting of a quarter of a pound of lye to ten quarts of water, will help to keep the scale out.

In driving, the spark should always be kept as far advanced as it is possible without causing a knock, for the lower the spark is carried the hotter the motor will get.

And this is where engine care is essential. When supplied with just the proper quantity of a high grade oil, when the gasoline mixture is right, when the valves are free from pits and seating properly, and when a correctly timed ignition system delivers a hot spark through clean and non-leaking spark plugs, the spark may be kept in a much more advanced position than if the power plant was not "running just right," as the careless owner would say.

And the man at the wheel should also remember that his low speed gears are supposed to be used at other times than when starting up. For "making everything on high" very frequently puts severe strains on the engine, and "strain" in this case is synonymous with "heat"; while care in avoiding excessive engine speeds when running on first speed will also materially reduce over-heating.

Carbon in the cylinder is a common cause of over-heating, as are the following: Poor mixture, water leaks, dragging brakes, slipping clutch, etc.

G. R. Petrie, Newport News, Va.

Causes and Cures

Overheating is responsible for Ford troubles and shortcomings not necessarily enumerated here, but brief mention of causes will be made, which will suggest remedies. Among the more common are slipping belt, carbon, late spark, low water, overfeed of gasoline, insufficient or inferior lubrication, clogged water passages, clogged muffler, leakage past pistons, slipping clutch, dragging brakes, and sometimes worn valve gear, occasioning too late and too little opening and too early closing of exhaust valves.

The use of hard water causes incrustation in water spaces which both insulate water from cooling and heating surfaces and retards circulation; it may be removed by filling the system with caustic soda solution, two pounds per gallon of water, and leaving it in over night. Great care should be observed in handling caustic soda, as it burns severely and is especially dangerous to the eyes. Another way is to use one part of hydrochloric acid to twenty of water preferably using it hot, and leaving it in the system half an hour. After either treatment the system should be well washed out. Another method, safe but very slow, is to use only rain water, changing it frequently. Of course only rain water should have been used from the first, when everything is in good order but little water is required and all incrustation is avoided. Unfortunately it happens that the very engine that overheats is the one which invariably goes on from bad to worse if the trouble is allowed to continue.

Number plates in front of the radiator will hinder cooling to a marked degree; with the larger plates the worst offenders.

Carbon in the cylinders is a common cause for excessive heating, and for this reason if no other its formation should be prevented so far as possible by the use of good oil in moderate quantity, avoidance of gasoline over-feed and the periodical introduction of kerosene or other efficient cleansing agent.

Pumps are advertised for increasing the water circulation, but their use adds complication and expense and destroys the peculiar benefits arising from thermo-syphon circulation. That pumps are unnecessary is proven by the thousands of Fords that are running satisfactorily without them. Their employment may be a distinct injury by masking the cause of trouble, which is then allowed to continue instead of being identified and remedied as it otherwise may be.

FRANK N. BLAKE, North Adams, Mass.

CHAPTER XXI

THE FORD CAMSHAFT

REMOVING AND REPLACING CAMSHAFT

DRAIN radiator and take it off.

Remove valve covers.

Remove lower crankcase cover or "door."

With valve lifter compress spring of one valve and raise the valve considerably off the push rod. Work the push rod up high enough so that a cotter pin or shingle nail can be pushed through the hole in the push rod shank.

Repeat with each valve and push rod.

Remove fan assembly and belt.

Remove commuator case without disconnecting the valves and lay it in the engine pan.

Remove commutator brush assembly.

Remove cylinder front cover. Get all cap screws and bolts out before trying to start it.

Take off large timing gear lock nut.

Turn shaft so that the marks on the teeth of the two gears are together.

Pull off large timing gear using puller (No. 1936 X, Parts Price List).

Remove from the side of the crankcase the two set screws that hold the middle and front camshaft bearings.

Pull out the shaft with the middle and front bearings on it. It will probably be necessary to use a light hammer through the crankcase door; at least, to start the bearings.

Mark the front end of the new shaft in such a way that it will be possible, after the shaft is in place, to tell at a glance which way the first cam points.

Fit middle and front bearings to the new shaft.

Shove back into place, taking care that the holes in the bearings line up with the set screw holes in the crankcase. It will doubtless be necessary to tap the middle bearing back a little to make the holes line up.

Put back the set screws.

Test shaft to see that it does not bind. If new bearings have been fitted, it may be stiff.

Turn so that cam number one points directly away from the crankshaft.

Put back large gear, meshing according to the marks noted before.

Put on large gear lock nut.

Put back cylinder cover using a new paper liner.

Put back commutator brush assembly.

Put back commutator case and control rod.

Put back fan assembly and belt.

Pull the pins from the push rods allowing them to set down in place.

Put back valve covers.

Put back crankcase lower cover.

Put back radiator and fill it.

C. S. Hall, New Haven, Conn.

Proper Procedure

After a considerable period of service the cams and bearings of the camshaft, through wear, will result in considerable loss of power, and the renewal of this part is necessary if it is desired to restore the power of the motor to its normal or original condition.

The removal of the camshaft of a Ford motor for inspection or renewal, as the occasion may require, is a simple procedure, and yet care should be exercised to see that every part is replaced in its exact position when reassembling.

Proceed by draining and removing the radiator, disconnecting the inlet and outlet water connections from the cylinder casting, unscrewing the stay rod that holds it to the dash and the two bolts that hold it to the frame.

Remove the cylinder head casting by taking out the cap screws, take off the valve covers on the right side of the motor, and with the aid of a suitable tool, remove valves and springs.

Disconnect the fan and fan bracket and the commutator cover without detaching the wires.

Remove the lower cover of the crankcase, the commutator brush or roller from the end of the camshaft and unscrew the cap screws that hold the front cylinder cover in place.

The front cylinder cover removal exposes to view the large timing or camshaft gear. The camshaft bearing screws, of which there are two, should not be unscrewed and the valve push rods raised up and retained in that position by fastening with twine or rubber bands.

The camshaft and gear may now be removed through the forward end of the motor.

Unscrew the lock nut and take out the dowel pins to remove the gear from the shaft.

In assembling the gear on the camshaft see that the first cam is on the opposite side of the shaft from the zero (°) mark on the gear, and in replacing the camshaft be sure to have this mark coincide with the mark on the small timing gear on the crankshaft.

The cast iron bearings which are retained upon the shaft by split rings can be placed in their proper positions by working through the opening in the bottom of the crankcase.

The remainder of the assembly is a reversal of the above procedure, but in replacing the commutator brush be sure that it is reinstated so that the first valve nearest the gear, which is an exhaust valve, is closed when the roller or brush is pointed upward.

The liberal use of shellac on the gaskets will insure against oil and water leaks.

G. A. L., Washington, D. C.

CHAPTER XXII

THE FORD TRANSMISSION SYSTEM

TROUBLE IN THE TRANSMISSION

IT is probable that worn transmission bands cause by far the largest part of the troubles experienced with the Ford planetary gears. As the linings of the transmission bands become worn and glazed, they will not grip the brake drums unless severe pressure is used and all the oil is squeezed out from between the bands and the drums. Then the bands are apt to take hold with a jerk, thus causing severe strains on the transmission and many other parts of the car.

It will be necessary to reline the bands; when the service brake does not hold in spite of all the adjustment that can be made through the transmission cover plate, when the low speed band slips and the motor races while the car is not moving as fast as it should, or when these bands engage with a jerky or chattering action.

As it is practically as easy to change all three transmission linings as it is to change one, because the largest part of the work is the removal and replacement of the transmission cover, it is advisable to equalize the wear between the three bands as much as possible so that all three will be worn out at the same time. By using the reverse pedal as a brake when retarding the car, but not making a complete stop, this will tend to wear out the reverse band at the same time as the foot brake, and the foot brake will last much longer if it is not so often used. By the alternate use of the reverse and foot brake on long hills, the oil will be given a chance to get between the brake drums and the transmission linings, thus preventing overheating and the charring of the band linings.

If the brake bands are allowed to chatter, the jerking will tend to throw the momentum of the entire car against the transmission drums. This is the most frequent cause of cracked transmission drums, and a broken drum means that the entire motor and transmission must be removed from the car in order that new parts may be installed. If an atttempt is made to run with cracked brake drums, the broken edges of the drum will soon cut the transmission bands to pieces and may result in severe damage to the motor and transmission.

The breakage of the transmission drums may be due to the use of iron, instead of soft brass rivets for fastening the linings to the transmission bands. These hard rivets will score the drums, and thus cause eventual breakage. It is not advisable to use band linings having metallic reinforcements, as the use of such materials not only tends to cut and score the drums, but some of the metallic particles worn from the linings are almost certain to short circuit the Ford magneto, which is in the same compartment, and cause the complete failure of the ignition system.

It is advisable to bend the ends of the rivets crosswise, so as to distribute the wear across the face of the drum. It is also well to countersink the rivets so as to reduce the wear on the drums as much as possible.

The chattering of the transmission bands may be due to not having these bands bent to conform to a true circle, so that they grip unevenly when pressure is applied through the foot pedal.

When applying the low speed gear the driver should press the pedal slowly but steadily, and when the low speed is once engaged, the pressure should be firm and hard, so that there will be no slipping between the transmission band and the low speed drum.

Other parts that sometimes give trouble are worn bushings in the triple gears. This is made evident by a sort of rumbling roar, when the low speed or the reverse are in use. The only remedy is to take the transmission apart and insert new bushings. As the bushings must be reamed to size, after they have been forced into the gears, this is not a task for the amateur repairman.

It is very seldom that the teeth of these triple gears show signs of wear, but when they are worn they will cause a growling sound. The teeth of these gears can be inspected through the transmission cover plate. It sometimes happens that the rivets holding the triple gears together are tight or not. It is also occurs, it is useless for the owner to try to tighten these rivets himself. For, unless the three gears are held in accurate alignment, while the rivets are being tightened, all the strain will be carried through one set of the triple gears instead of being distributed among the three sets of gears as it should be. It is not generally possible to tell by the sound whether these rivets holding the triple gears together are tight or not. It is also important that the teeth of the driven gear be in good condition, as this gear receives considerable wear.

A sprung crankcase might cause a grind in the transmission, and if the car has been bumped against an obstruction on the road it is well to inspect this part as a possible source of trouble. As the rear of the transmission is supported by the universal

ball cap and has a babbit lining, this lining should be inspected for wear, for if it is badly worn it will throw the transmisson out of alignment.

MURRAY FAHNESTOCK, Pittsburgh, Pa.

Proper Lubrication the Most Important Factor

With the planetary or epicyclic speed gear and combined multiple disc clutch, the type of transmission employed in the Ford car, in which the gears are always in mesh, there is remote possibility of injury to mechanism, except through defective parts or by an accident, and under ordinary conditions of usage, it should offer no necessity for its overhaul under some twenty thousand miles of the car's travel, but adjustments of the restricting bands and clutch spring are necessary when the conditions demand.

The contracting clutch bands which are faced with an asbestos lining will sometimes become glazed, a condition evidenced by their engaging the drums with a jerky action, under which conditions they should be relined or replaced.

The action of the glazed bands is detrimental to the welfare of those parts which are affected by the harsh torsional strains to which the universal joint, propeller shaft and rear axles are subjected and has a tendency to crystallize the metal, resulting in frequent unaccountable breaking of these parts.

Loosened rivets and bolts in the chassis may be attributed to the strain that this harsh jerky action of the band acting through the transmission imposes upon the car.

The glazed conditions of the asbestos lining is the result of wear, excessive use, or a change of lubricant. A change from an oil having a paraffin base to one with an asphaltum base will result in this condition; whatever may be the cause the only remedy is to replace them.

With this gearing, when low and reverse speeds are used there is an unusual amount of friction, which results in rapid wear of the bearings. Worn bearings cause the gears to emit a pronounced whirring or grinding sound. It is necessary under these conditions to have the bearings replaced by a mechanic with proper equipment and tools necessary to force the old bearings out and the new ones into place, reaming them out to the proper diameter to fit snugly upon the shafts.

The multiple disc clutch seldom needs attention, the only requirement being the proper tension of the coil spring to give sufficient frictional contact between the plates. If there is a tendency for the car to move forward when the motor is cranked, this is due to the oil congealing between the surfaces of the clutch discs.

A lighter grade of lubricant or a thorough cleansing of the crankcase with kerosene is necessary, for oil which has been used for a considerable period of time becomes dirty and is unsuitable for use because of its waxy consistency.

The transmission bands should always be adjusted loosely to prevent them from bearing against the revolving drums, producing wear and friction. Proper lubrication is the best attention that the individual should give this particular transmission and if repairs are necessary place them in the hands of a competent mechanic familiar with this type of car.

G. A. L., Washington, D. C.

REPLACING THE TRANSMISSION BANDS

THE removal and replacement of the three transmission bands of the Ford car is one of those jobs which can be more easily and quickly done with the help of a little headwork than by using only main strength and awkwardness.

I am going to try to describe my method of performing this operation with one hand. (I use but one because I have but one to use.)

First, disconnect magneto wire and remove all bolts holding transmission cover on and lift the cover off (take the whole cover off, not just the door). The bands may then be removed by slipping them forward over the triple gears, one at a time, turning part way round and withdraw by spreading open slightly.

When ready to put them on again you can readily slip them back over the drums in the same manner in which they were removed. Then comes the replacing of the transmission cover, and, in the words of the inimitable Cal Stewart, "that's the time when the fun begins" if you go at it in the way which seems to be most commonly done. But the proper way is to take small copper or other soft wire and put around the "ears" on the ends of each band and twist the wire up until it draws the band up tight on the drum. Do this with each band and then take your transmission cover and remove the adjusting nuts, washers and springs, remove the pedals and lay them aside. Now with a pair of tongs or wide-mouthed pliers compress each of the three springs and slide it into its place between the ends of the band. Next replace the transmission cover, and in doing so see that the clutch release ring goes into its groove in the shift; put a bolt in on each side of the cover to keep it in place, after which proceed to replace the pedals by starting with the front one (R) and sliding it carefully through the "ears" and the spring far enough to start the washer and adjusting nut on.

Next put in the rear pedal (B) in the same manner, and last the middle one (C). After the pedals are in, cut the wires and draw them out, being careful not to drop any into the inside, as they would probably cause trouble with the magneto. Adjust the bands up close, but not enough to make them drag. I have found a small wrench, made especially for these particular adjustments on the Ford, to be almost indispensable. They are usually made with a hole in the end of the handle for attaching a cord for use in case the wrench be accidentally dropped into the inside.

Now replace remaining cover bolts, and put on transmission cover "door," and the job is done.

I have completed this whole operation with one hand and without help in one-fourth the time I have seen a professional repairman, with helper, take for the same job simply because they tried to put the cover on, keep the clutch release ring in place, keep the bands in place and force all three springs into position all at the same time, and if you don't think that is some job, just try it.

A. C. J., Boston, Mass.

CHAPTER XXIII

TRANSFORMING THE FORD INTO A SPEEDSTER

IN remodeling a Ford car into a speedster, three factors stand out as being essential in obtaining the desired results. They are as follows:

1. Maximum efficiency in all mechanical parts.
2. The reduction of wind resistance.
3. The lowering of the center of gravity to enable the car to hold the road at high speeds.

Cooling: If the car is to be used for any sustained periods of fast driving, it would be advisable to replace the present radiator with one of greater capacity. A radiator of the "V" type would be preferable, as this would meet all needs for cooling and also adapts itself readily to the method of lowering the frame outlined later in this article. Another safeguard against overheating would be the installation of a reliable water-circulator which should be selected with the greatest care as its failure to perform its functions might result in serious damage to the motor.

Oiling: With the splash system of oiling as used in the Ford motor, there is no constant oil level in the crankcase when the motor is running, so that an oil gauge would be of little value. However, an auxiliary oil reservoir could be installed to supply oil to the crankcase either by gravity, and controlled by a petcock on the dash, or by a small pump.

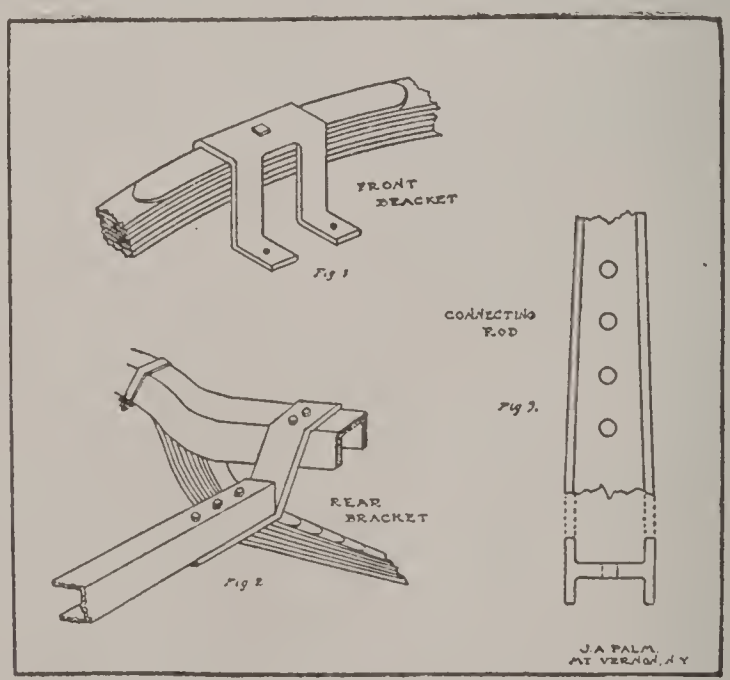
Ignition: Although the Ford magneto will give good results if the vibrator points are carefully adjusted and all wires properly insulated, a high tension magneto will give increased power and greater flexibility to the motor.

Motor: In the motor, several changes can be made which will increase the power. The first change would be to reduce the weight of the pistons and connecting rods either by substituting aluminum pistons, and connecting rods or lightening the weight of those already in the car by drilling holes in them. In the pistons, these holes should be ¼″ in diameter, and placed ¾″ apart, just below the wrist pin. In the connecting rods, five holes, spaced ¾″ apart, drilled through the thin part of the I-beam section will be sufficient. (Fig. 3.) As the weight of

the pistons should be approximately equal, it may be necessary to drill additional holes in some of the pistons to bring them down to the weight of the lightest one. If the cylinders are scored or badly worn, it would be advisable to have the block rebored and oversize pistons fitted.

Another change would be to advance the valve timing by moving the camshaft one or two teeth forward. To get the maximum results, it would be necessary to have a new camshaft made which would give a longer valve opening.

There has lately been put on the market, for use on the Ford motor, a cylinder head containing 16 overhead valves and their attendant mechanism. It is claimed that a Ford car, geared for



speed, and equipped with this cylinder head, attained a speed of over 75 m.p.h.

A larger carbureter and larger intake and exhaust manifolds will contribute toward increased power in the motor.

The use of a foot accelerator, of which there are several types for use on Ford cars, will prove to be of great convenience.

No changes in the transmission are advised.

In the rear end, the only change would be to substitute the present pinion and crown gears which have a ratio of 3.63 to 1, with new gears having a ratio of 2.75 to 1.

If any trouble is being experienced with the ball bearings in the front wheels they should be replaced with roller bearings.

The solution of the problem of reducing wind resistance can be brought about principally by the mounting of a new body.

This should be low and of the streamline type. It can either be built to order, bought ready made or built by the car owner himself. In this, the owner will be governed by his purse. If built by the car owner, it would be advisable to buy a set of patterns. These patterns, together with such parts as the tail piece, which the amateur builder is not in a position to make, can be obtained for a nominal sum. The parts which offer the most resistance to wind are the fenders, windshield and top. They should be eliminated. The rear of the body should be pointed to decrease the effect of suction. The seats should be lowered, which will mean lowering the steering post.

To solve our third problem, that of lowering the center of gravity, the method employed will probably require the services of a blacksmith but as the work to be done is very simple, the cost should not exceed $15. The frame should be lowered about five inches. This will necessitate the making of one front and two rear brackets as shown in Figs. 1 and 2. The front bracket, which should be made of ½ by 5 inch stock, clamps over the front spring and the bottom ends are bolted to the front cross member of the frame. The rear brackets, of ½ by 2 inch stock, are bolted to the rear cross member of the frame after the frame has been sawed off as shown in Fig. 2. In connection with the rear brackets, great care must be exercised not to alter the position of the rear axle in relation to the frame either backward or forward. A longer starting crank will be required, but if a "V" type radiator is used, as suggested, a new crank will be furnished with it. This style of radiator also projects over the front spring and improves the appearance of the front of the car. As the front axle will now be slightly in front of the frame, it will be necessary to lengthen the front radius rod about 3 inches by cutting and welding in the necessary amount. The steering knuckles should be bent down enough to allow the tie rod to clear the radius rod and crankcase.

J. Adam Palm, Mt. Vernon, N. Y.

Reduce Weight and Wind Resistance

In my opinion, in converting a Ford car into a speedster, the following should be taken into consideration. One great factor which limits the speed of a car is weight and wind resistance. Consequently, the weight must be decreased to a minimum, and the mud-guards removed. It would be best to have a special racing body built out of sheet metal, a streamline one, having a long tail—which offers the least resistance to wind. Since the cost of labor would be rather expensive in building this body, you would have to content yourself with a stock racing body or adapt one yourself with bucket seats.

In order to keep the car on the road at high speeds, it is essential that the chassis or frame of your Ford be underslung. This is made possible by using brackets or "goosenecks" in lowering the chassis. By this arrangement you can also increase the wheelbase a few more inches, thereby increasing the riding qualities of your car.

The next step to follow would be to fit in a larger carbureter, a high-tension magneto, although you will find any one of the standard makes of battery systems will give very good results.

A racing camshaft may be installed. After this is installed, the timing gears should be set ahead a notch at a time until the best results are secured.

Counterbalances may be used. This will give you a smoother running engine. Lighter connecting rods may also be used. Also lighter pistons, and any standard makes of piston rings may be used to great advantage in lightening the working parts of your Ford engine in high speed work.

After any or all of the above equipment is installed, you will find the engine will have considerably more speed and power.

C. C. Leong, Hakalau, Hawaii.

CHAPTER XXIV

THE CONTROL SYSTEM

IMPROVING FORD CONTROLS

A FEATURE in the Ford control that requires practice to accomplish without stalling the motor is that of reversing the car.

To reverse this car it is necessary to set the hand lever in neutral position and as there is no means for readily determining where the lever should be placed, I overcame this fault with a simple slot or depression cut into the speed lever bracket on the control shaft.

The advantage of this slot is that when the hand lever is moved, the clutch lever bracket adjusting screw drops slightly into the depression and when the foot is removed from the clutch pedal, the screw does not slide down the incline on the back of the speed lever bracket, engaging the high speed clutch and stall the engine. Additional to stopping the motor from premature engagement of high speed, another condition is that when the hand lever is pulled back too far it engages the emergency brakes, under which cir cumstances, when the reverse pedal is used, it has to move the car against the brake pressure or otherwise, as is usual the engine is choked. The depression can be cut with either file or saw at the apex or point where the inclined face and curved surfaces on the speed lever bracket meet and should be about one-sixteenth of an inch by three-eighths of an inch wide.

To obtain the best results from the carbureter on the Ford under various running conditions, where sand hills and mud are encountered, the dash needle valve adjustment needs frequent manipulation. High gasoline mileage requires adjustment for a lean mixture, while for heavy pulling with an open throttle, the needle valve needs opening to provide more fuel for the increased slow moving volume of air.

To overcome the necessity of reaching forward to the right of the dash with the accompanying danger of running off the road, while adjusting the needle valve and additionally evade the oft-repeated question of "what is that for?"

from the occupant of the adjoining seat, I attached an adjusting rod under the steering column with a connecting lever to the adjusting needle stem, making it as easy to turn the needle valve as to open the throttle. The adjusting rod is fastened to two small clips to the steering post, with a hole drilled through the dash flange for the rod to pass. The connecting rod passes through the opening on the cylinder block and is fastened to the adjusting needle by a sheet metal strip on the needle stem, this being held by the prongs of the dash adjuster.

To complete the attachment I shaped a piece of sheet brass to go under the bent ended dash adjuster. The sheet metal dial is stamped with the words "hot and cold" and intermediate lines marked off for adjustment to a degree of opening. The end of the dash adjuster was filed to remove some of the flattened end and make the indicator more finished in appearance.

Some owners will often wonder how others obtain high mileage from gasoline on Fords, the secret lies in the use of the needle valve, the control as suggested simplifies its adjustment. Additional to being economical a lean mixture results in a cleaner engine interior and less spark plug sooting, for the excess oxygen accomplishes a more complete combustion.

G. A. Luers, Washington, D. C.

THE THIRD OF THREE

"What makes more noise than a pig under a fence?" We all know that the answer is two pigs, which is a self-evident truth. Now let us try another question, as to what is nicer than a girl, and the logic is two girls, although two girls are sometimes more conversational than logical.

Having proved the necessity of carrying three persons in a runabout, or in the front seat of a Ford touring car, we now can show the possibility of changing the control system so that three passengers can be carried.

When carrying the third of three, the seat cushion is pulled forward a couple of inches, the driver sits back in one corner, the middle passenger sits forward a little, and the other passenger sits back in the far corner. Now the driver can only reach the clutch and reverse pedals conveniently, but this is enough for a good driver. The reverse can be used as a brake to retard the progress of the Ford car, and the car can be stopped entirely by the simple use of the hand brake.

An accelerator cannot be used with the left foot, for that foot, is needed for clutch control. When operating the clutch, the

throttle is most needed. The accelerator, even if one is used, cannot be reached by the driver's right foot, when there are three in the front seat, because the passengers interfere.

Since the driver is so far to one side, he can reach the left hand lever as easily, but he has to reach around the steering column to get to the right hand lever which controls the throttle. This is unfortunate, because the spark lever does not have to be moved often, but the throttle has to be changed frequently, for traffic driving, or rough country roads.

It is possible, of course, to transfer the spark and throttle controls, under the hood, but this is not easy, because the throttle rod is not long enough to carry the spark lever rod arm at its lower end. The change involves no more than a couple of hours repairshop work.

For this reason, I have made an extension throttle arm, from a piece of copper tubing. This tubing is almost flattened at one end, so that it slips easily over the flattened end of the throttle lever. It is held in place by a cotter pin, which slips through a hole drilled through both tube and throttle lever. The tube is bent over, and reaches across to the other side of the steering column. Thus, it is easy to manipulate both spark and throttle controls with the left hand, while steering with the right hand, without continually bumping into the passengers. When driving alone, or with only one passenger, the tube is easily taken off, and the control is normal.

I have also mounted a switch, on the side of the body, next to the driver's seat, so that the igntion can be easily switched on and off without disturbing the passengers.

MURRAY FAHNESTOCK, Pittsburgh, Pa.

CHAPTER XXV

THE STEERING SYSTEM

FOR EASIER FORD STEERING

ATTACHMENTS for the Ford steering gear are designed either to make steering more safe and easy, or to eliminate noise resulting from wear in the ball joints or spindle arm bushings, or to separate the Ford owner from his money.

Most devices of the first group are intended to help the driver to keep a straight course and to assist in bringing the front wheels back to the straight position after turning a corner. This is accomplished by means of springs which resist any movement of the steering gear to the right or left. In my experience, when a Ford driver feels the need of such a device to help him stay on the road, the trouble is due either to a bent wishbone, to front wheels out of line, or to badly worn spindle body bushings. If these conditions are remedied and the steering gear well lubricated the car will "hang straight" on a flat level road and, after rounding a curve, it will straighten out almost of itself.

Wear in the ball joints, if taken up according to the instructions given in the Ford Manual, is a constant source of noise and trouble, and when the ball in the upper joint gets worn out of round this method becomes impossible unless new parts are installed, for if the cap is filed enough to stop the rattle when the car is on a straight road the joint will bind when turning a corner. The familiar, adjustable, spring type of anti-rattler which replaces the ball cap gives excellent results if made of good material, an essential qualification.

Wear in the spindle arm joints produces vibration and noise which, once started, becomes rapidly worse. If allowed to proceed the bushings themselves will get loose. The usual remedy is to renew the bushings. If the spindle body bushings are not renewed at the same time the steering gear will turn easily with both front wheels jacked up but when the jacks are removed the spindle arm joints will bind because of play in the body bushings. Adjustment by renewing the bushings is satisfactory but short-lived unless vibration is eliminated by means of some sort of anti-rattler.

There are three types of anti-rattlers for this joint. One substitutes a taper bolt which can be screwed down into a taper

bushing as wear occurs. The trouble with this method is that wear never occurs equally on all sides of the bushing or bolt and adjustment is apt to cause the joint to bind. Another method employs a U- or V-shaped spring that fits between the throat of the connecting rod yoke and the end of the spindle arm, producing a lateral pressure on the spindle arm bolt. This device stops the rattle and is easily applied but it actually helps slightly to wear the bushing out of round, and is inferior, I think, to another type. The latter consists of a device for exerting a downward pressure on each end of the connecting rod. This may be done either by a pull on the bottom of the spindle arm bolt or by a push on the top of it. An appliance for doing the pulling has given me fairly good service but a much simpler device of my own has proved even better.

The success of such an appliance as the foregoing can be greatly increased if, at the time of installation, the old spindle arm bushings are replaced with spindle body bushings reamed out to fit the spindle arms bolts. This gives a bronze flange for the wear due to the weight of the connecting rod and the pressure of the springs, and at the same time fills the space caused by previous wear. If there is not room enough for the flange between the arms of the yoke a little stock can be filed from the top surface of the arm where the flange will seat or the flange itself can be filed thinner. This arrangement, in addition, puts an end to annoyance caused by a loose bushing, a condition arising often enough when plain bushings are used.

I might add that an attachment between the oil can and the driver, which results in constant lubrication of the steering gear joints, is about the best that can be secured to keep the efficiency of the Ford steering mechanism at its best.

E. S. Hall, New Haven, Conn.

Getting the Best from a Multitude

Accessories and attachments for the Ford steering gear are almost legion, and no private owner can hope to experiment with all of them. I have tried a fair share of them in the last two or three years, however, and it has been my experience that very few such attachments are really necessary.

The most prominent steering gear attachment is probably the type of device which clamps to the center of the front axle and the spindle tie rod, and by means of springs pulls the spindle tie rod back to a central position whenever the wheels are turned. I had a device of this type on my car for a time last season, as the car was rather hard to steer. I found that this device certainly made steering quite a bit easier. When I had had it on the car a couple of months the front radius rod broke at one

end and I installed a new one, and after that I noticed that the car was easier than ever to steer in a straight line; but it took quite an effort to turn. As an experiment I removed the auxiliary steering device and then found that the car steered perfectly.

As nearly as I can figure it out there must be some variation in the length of front radius rods, and the second pair were probably a little longer than the first, and so held the front axle a little further forward. This gave a caster effect which was not present, at least not to the same extent with the old radius rods.

I have since found that by bending the front spring perches slightly the axle can be tilted forward and the same effect obtained.

The auxiliary steering device used last summer has since been discarded.

A larger steering wheel (17-inch size) makes steering a lot easier. A tilting type is convenient, but not necessary.

Anti-rattlers and adjustable ball sockets are very much advertised and they are very handy things to have, after a car has been in use for a few months. A good substitute for the spring type ball socket caps is to use two fan adjusting screws with castle nuts (the same size as those used on the crankcase bolts) and front radius rod stud springs, using the standard steering ball socket cap. Of course, the fan screws must be drilled near the end for cotter keys. This can be done by running the plain nut on the screw and then the castle nut, locking the two together in the proper position by turning them against one another, and then drilling the cotter pin hole between two of the prongs of the castellated nut.

"Wolverine," Detroit, Mich.

CHAPTER XXVI

THE REAR AXLE

STRENGTHENING THE REAR AXLE

THE "Universal" car comes into this world in much the same condition as the rest of us. It is supplied with all the necessary parts to make it go, but is stripped down to the skin in so far as improvements are concerned. This is a necessary feature of a car designed to meet the needs of such a widely varying class of purchasers.

The most complete line of accessories is available for those who take enough interest in their cars to improve them. This line is so extensive that one can complete his Ford to suit his own individual taste.

Unfortunately there is a natural tendency to select those accessories which add to the appearance of the car, and to neglect those which serve only a utilitarian purpose.

Those fittings designed to reinforce the rear axle assembly come in the latter class and are not generally given the consideration they deserve. The differential and the geared connection with propeller shaft form a three-point drive which must be kept absolutely rigid if strains are to be kept at a minimum. There is more or less flexibility to the spherical differential housing, as can be easily seen by watching the rear axle of a car running over a rough road. In order to reduce this a rear axle truss is almost a necessity. This is a truss rod fitted with turnbuckle and attaches to break drum housings by means of splint clamps. Its attachment takes but a few minutes time and its cost is less than one dollar. If it saves one gear breakage it pays for itself many times over.

The joint between the propeller tube and lower flange connection is subjected to very severe strains, particularly when sudden changes in speed occur. In order to correct this there has recently been placed on the market a malleable quadrant brace which clamps the propeller tube and bolts to top of the differential housing; thereby effectually stiffening this weak point of the rear assembly.

When wear occurs between the differential thrust washers

the large gear moves away from the pinion, transferring the strains to the outer ends of the gear teeth. This is the usual cause of gear breakage. The cure for this is naturally to replace these thrust washers before the wear becomes excessive. Unfortunately it is necessary to take down the entire rear assembly to detect such excessive wear. Assuming proper lubrication, a safe rule is to take it down at the end of each season's running, or from 5,000 to 7,500 miles' use. When the differential is opened up it is a real economy to substitute a ball thrust for the usual form of washers. The life of these patented ball thrust washers will be equal to that of the car and their cost well spent if they save a gear breakage.

The installation of shock absorbers is usually decided upon on account of the smooth riding qualities. It is not generally realized by the average car owner, that they also serve to reduce the upkeep and general wear and tear by reducing the hammer blows from a partially cushioned chassis and body. The rear assembly comes in for its share of these.

In the matter of lubrication the rear assembly generally gets too much where it is not needed and not enough where it is essential. The differential housing should be kept reasonably full of a fairly thin grease. It should not, however, be packed to such an extent that the grease must find an outlet by way of the emergency brake housings and drums. In order to avoid this it is necessary to renew the felt washers between the outer bearing caps and the inside of rear hubs quite frequently. There have been a number of special devices marketed with the idea of correcting this annoying feature. The best of these is a combination of a spiral which slips over the shaft and a set of metal and felt washers. This device goes back of the outer roller bearings and serves as a screw pump to feed back any grease which works out along the shafts. Its cost is considerably less than one dollar and, on the score of cleanliness alone, is well worth its price.

The regular emergency brake bands of the Ford, being an iron to iron proposition, give poor results at best, and are practically useless if drums are full of grease. The cure for this is the substitution of bands lined with regular brake lining. In selecting these obtain if possible those made of one piece of band steel. The others, in common with the regular cast unlined band, occasionally break and, when they do, make a nasty mess of the inside of your brake

housing. A bent shaft and badly scored drum is almost sure to result.

Lubrication by means of oil is a mistake when applied to the spring shackles, both front and rear. Any slow moving bearing needs grease and not oil. To correct this faulty means of lubrication substitute small grease cups for the oil cups on all shackles.

Proper spring lubrication is neglected by the average car owner. To spread the spring leaves for insertion of grease is a trying and messy job. Oil squirted on the outside runs off before it can enter between the leaves. The only practicable means of keeping springs lubricated at all times is the attachment of spring oilers. These are of many forms, but all on same principle—a metal cup in which is placed a heavy felt pad to hold the oil. These oilers act by supplying a very small amount of oil continuously, while the springs are in motion. Rusty springs and breakages go hand in hand, one broken leaf will pay for several sets of spring oilers.

After having attended to all these points there is still left one spot which is the source of a continuous and annoying squeak in most cars. This point is where the rear spring is bolted inside of the rear frame channel. You will notice a pair of bright spots on your spring just below the lower edge of this channel, the width of this representing the maximum movement of the spring at this point. To kill this squeak simply soak pieces of soft rag in oil and force up tight in the triangular pocket formed by the frame channel and the top arch of the spring. Renew these from time to time and you will have a quiet running rear spring action.

As the total cost of all the fittings mentioned above is less than ten dollars, or about the cost of one ordinary rear assembly breakage, they are unquestionably a good investment. In addition you have the satisfaction that results from a smooth running car. Their attachment involves little time and is within the ability of anyone with sufficient knowledge to warrant his operating an automobile.

S. B. Hood, Minneapolis, Minn.

A Little Paint for the Lily

The transmission band linings are probably the greatest source of repair expense on the average Ford car. But if these bands are taken care of there will be less depreciation on the other parts of the car, espcially the rear axle parts and less liability of accident. As the cost of these

band linings is small, compared with the cost of installing them, it is wise economy to purchase the very best grade of band linings obtainable. The usual charge for installing a set of band linings is $2. A set of the best band linings costs about $3, making a total cost of $5. Now the cheap band linings cost about seventy-five cents, including rivets, making a total cost of $2.75. Thus, by paying about twenty-five per cent more, a 200 or 300 per cent better job is obtained, and the car does not have to be sent to the shop so often, at the loss and the inconvenience of the car owner.

Skillful driving will easily make the bands last twice as long and will also be easier on the entire car. There is a knack in applying the Ford pedals, and the peculiar construction of the Ford transmission must be understood by the car driver in order that the best results may be obtained. Now these transmission bands are applied to cast iron drums and constantly run in oil. But more bands are ruined by charring than by actual wear. This charring forms a glaze on the fabric lining that makes the bands slip until they are pressed onto the drums with great force. Then these glazed bands seize the drums unevenly and chatter, causing strains that are injurious to the motor and rear axle parts and are hard on tires by causing the wheels to slide. Charring of the bands can be prevented by using the brakes alternately on long, steep hills. By applying the brakes intermittently, the oil has a chance to get between the brake linings and the drums, thus cooling them off before the bands become hot enough to char and burn.

HARRY A. DERSTINE, Quakertown, Pa.

MAKING REAR AXLE GREASE TIGHT

MY Ford car caused considerable annoyance by leaking grease from the joint where the halves of the differential housing were joined.

The remedy that I adopted and found successful was an inexpensive double truss-rod.

Cut shows how this double truss-rod is attached.

Refer to Fig. 1. Truss-rod A-A passes under the differential housing. Truss-rod B-B passes back of the housing.

Without truss-rod A-A, rear axle sags and housing bolts at bottom stretch, thus opening joint X-Y at the bottom. Truss-rod A-A when attached prevents sagging and relieves strain on bolts. Joint X-Y stays tight at the bottom.

Refer to Fig. 2. Strut-rods C-C and D-D should be kept

tight. Propeller-shaft tube E-E takes the strain caused by tightening the strut-rods and forces the differential housing backward, stretching the housing bolts at the rear and opening joint X-Y at this place.

Truss-rod B-B when attached prevents this backward movement of housing, and removes the strain on housing bolts. Joint X-Y stays tight at the rear.

Summing up. Truss-rod A-A prevents joint opening at bottom. Truss-rod B-B prevents joint opening at rear Strut-rods with propeller shaft tube prevent joint opening at front.

It is a very simple, inexpensive and effective remedy.

Leakage of grease at the brake drums is a very disagreeable and dangerous feature. Besides smearing the rear wheels, this grease puts the brakes in a practically useless condition. The best remedy for this trouble is to renew the felt washers at the outer rear axle bearings.

The cause of this leakage in the majority of cases is an excess of lubricant in the differential housing. By the time that this grease has reached the outer roller bearings in the rear axle housing it is practically worn out as a lubricant, and if it could be removed from the housing, it would be a benefit to the bearings. It can be got rid of in the following manner: Refer to Fig. 1. Drill a quarter-inch hole through bottom of axle housing at outer ends as shown in cut. This will allow the surplus grease to work out at these two places. In practical use, I have found that none will drip except when the wheels are turning. Your garage floor will stay clean.

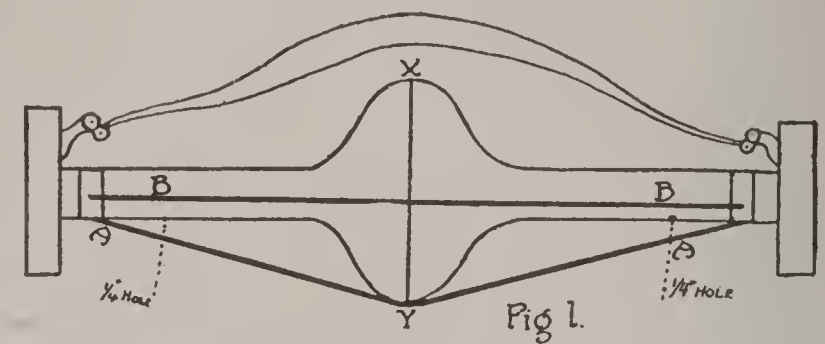
GEO. S. BROWN, Norwich, Conn.

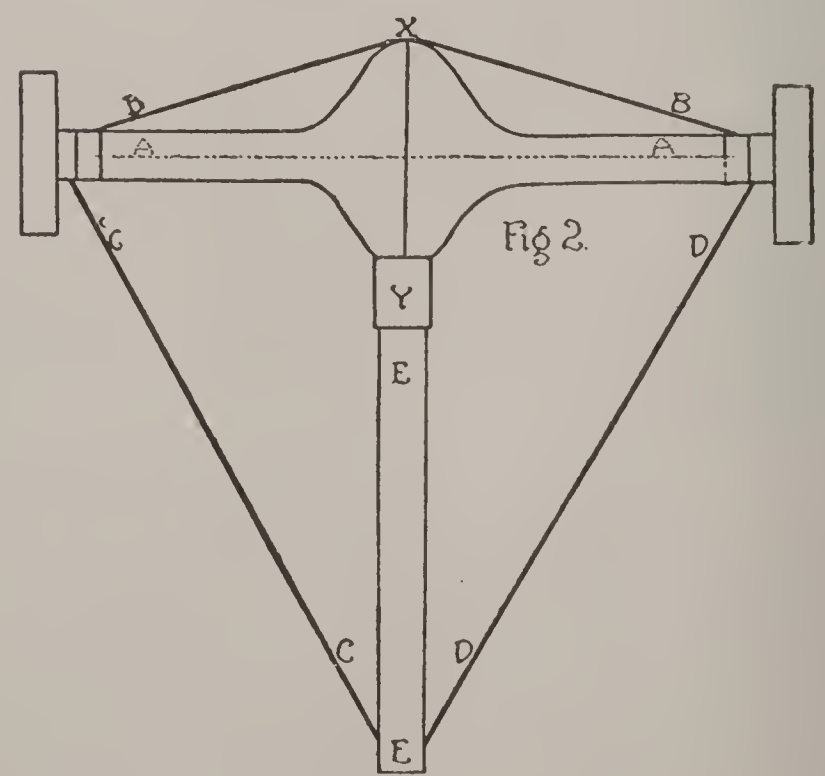
No Special Device Needed

Many suggestions have been offered as a means of preventing grease from leaking out around the rear wheels of a Model T Ford car. It has been the experience of the writer, however, that no special device is needed provided the grease used is of the proper consistency and provided there is not too much grease used. It has been found by actual measurement that one gallon of fluid will entirely fill the rear axle housing of a Model T Ford; however, it is not necessary to entirely fill the axle housing, neither is it necessary to make it half-full, as a great many owners are in the habit of doing—the best results will be obtained when the grease takes up a little less than one-fourth of the total capacity, or approximately three pints.

Any good gear compound may be used, but it should be of a semi-fluid grade; in fact, the writer has obtained excellent results with heavy steam cylinder oil.

Some owners use a "cup grease" in their rear axle, but satisfactory results cannot be obtained from cup grease because of the fact that the grease cut "tracks" into its





Geo. Brown Rear Axle Greastight

body, thus preventing anything more than momentary contact with their teeth and the other parts requiring lubrication.

A great many owners imagine that it is necessary to entirely fill the rear axle housing in order to lubricate the axle shaft roller bearings. This, however, is a mistaken idea,

as the inner roller bearings get sufficient lubrication from the grease thrown off the differential gear, and provision has been made to supply the outer roller bearings through the grease cups—one on each end of the axle housing. These cups should be screwed down two or three turns each week —each cup holds sufficient grease for 500 miles.

If the above directions are followed closely the owner will have no cause to complain of grease leaks.

If you are already bothered with a grease leak, on account of too much grease having been put into the axle, the trouble can easily and quickly be remedied as follows:

Jack up the axle on the side where the grease leak is, so wheel will clear the ground, remove hub cap, take cotter pin out of the end of the axle shaft and remove the rear hub lock nut. Next remove the wheel (it is advisable to use the regular Ford wheel puller for this purpose), remove the rear hub key. Next remove the axle housing cap, this can easily be done by gently forcing off with a screwdriver. Next take a small wire and catch hold of the end of the axle shaft roller bearing and pull it out. Next lower the jack so that the outer end of the axle housing will be about six inches lower than the center, then start motor and allow it to run in high gear for several minutes. It will now be observed that the surplus grease will begin to run out of the axle housing. This operation should be continued as long as the grease runs freely. The motor should then be stopped and the gears placed in neutral. By means of a piece of waste or rag attached to a small iron rod any grease remaining in the outer part of the housing can be swabbed out.

As the cost of the axle outer roller bearing felt washer, together with the rear hub felt washer, is but ten cents, it is advisable when assembling to replace these parts with new ones.

It must be remembered that it is only necessary to put grease into the differential case (or axle housing) once every 1,000 miles, and then only one-half pint. A little forethought and systematic inspection of the lubricant containers will obviate most lubrication troubles.

R. C. B., Pittsburgh, Pa.

CHAPTER XXVII

THE RUNNING GEAR

WHEELS, RIMS AND TIRES

HAVING experimented with undersize tires and oversize tires in equipping a Ford, my experience has proven, very conclusively, for me that oversize tires possess other advantages than economy.

The larger tires carry an over-burden without damage; they negotiate sand and mud roads more readily and reduce considerably the chances of a puncture or a blow-out.

The change to oversize was not made in the front wheel equipment as is usually done, by adding 31 x 3½ inch, but 31 x 4 inch tires were used to replace the 30 x 3½ inch rear shoes and the front tires 30 x 3 inch remained the same.

Normally the small tires ran from 10,000 to 12,000 miles before they needed replacing, while the rear tires would never give over 5,000 or 6,000 miles of wear. The 31 x 4 inch shoes, run from 8,000 to 10,000 miles, with a singular freedom from trouble, which nearly equalizes the tire wear all around.

Previously, I used interchangeable equipment of 30 x 3 inch tires on a two passenger car. This was made possible by purchasing from the Ford agent 30 x 3 inch wheel spoke and rim assemblies, which was used to replace the rear wheel spokes and rims. The wheel change cost about four dollars and the tires cost about one-third less than 30 x 3½ inch.

While the tires were interchangeable, they might just as well not be so, for all the changing done was on the rears.

We looked for blow outs weekly and they occurred with alarming regularity, it being a matter of only a few months before the small tires were discarded, as being entirely inadequate for their task.

It is possible to equip with the same size tires 30 x 3½ inch all around, by purchasing for only a few dollars the rear wheel spoke and rim assemblies and placing these on the hubs of the front wheels.

The general appearance of a Ford is bettered by the addition of demountable rims and larger front tires, but it

seems hard to convince a Ford owner that he should carry around an extra tire and rim to obtain the convenience that this equipment provides. I have found that the spare tire if placed in the curved face of the left front fender (as on the Hudson) and held by four clips, two near the running board and two about eighteen inches up on the fender, with buckled leather straps and a tire iron, with pad-lock attachment, bolted immediately behind the left side lamp, the spare improves the appearance of the car and in no way interferes with the oiling or greasing of the rear axle as when a rear tire holder is used, nor does it interfere with opening the left side door.

Any one who has driven a Ford equipped with wire wheels will agree that this feature adds materially to the riding qualities, offsetting to a large extent the stiff action of the short springs.

I have not as yet added wire wheels to the Ford I drive, but it is my intention to do so, as I believe the ideal equipment will be the combination of wire wheels with oversize 31 x 4 inch tires on the rears.

The wheels which I intended to use are not of the demountable variety, but of the plain clincher type, interchangeable with the hubs and tires now used and cost about thirty dollars for the complete set.

There is no questioning the fact that wire wheels add materially to the mileage of the tires and, though the initial cost may be high, the ultimate saving in tires and the car's mechanism, not to mention the improved riding qualities, make this investment worth serious consideration.

G. A. Luers, Washington, D. C.

Oversize and Double Tread

In the spring of 1914, I purchased a new Ford car and by careful driving was granted immunity from tire trouble until the fall of that year. After series of punctures, which in some instances made it necessary to remove a left casing on narrow roads subject to heavy traffic, I resolved to turn a twenty minute job into a five minute one by equipping the car with demountable rims.

My resolution resulted in the purchase of a set of four wheels equipped with demountable rims, and one extra rim, of the type secured to the wheel by five bolts. These rims are of the clincher type, split diagonally and kept in alignment by a plate and four lugs, two each side of the valve stem. When the tire is on the rim, the plate, which

contains five holes, slips over the valve stem and the four lugs. The lugs project about ⅜ of an inch above the plate and fit into four holes, in the felloe, which prevents the rim from shifting with its consequent tearing off of the valve stem. The rim, being split, is flexible, which greatly facilitates the removal or replacement of a tire.

The additional weight of the demountable rims and the larger tires on the front wheels has no apparent effect on the starting, stopping, hill climbing, steering or mechanism of the car. If any additional gasoline is consumed because of this extra weight, it is negligible and more than compensated for by the saving in tires.

Briefly, the advantages offered by the use of demountable rims in place of the plain clincher type are as follows:

1. In time saved, especially in stormy weather or heavy traffic; the disagreeable part of the work being done in the garage.
2. In increased tire mileage, due to the use of oversize tires on the front and the practicability of moving tires from the rear to the front wheels or vice versa.
3. In the interchangeability of casings and tubes thereby permitting fewer spares to be carried.

My experience with oversize tires was gained through the use of demountable rims which necessitated the use of 30 x 3½ inch tires on the front wheels instead of the standard 30 x 3 inch and also by the use of "double tread" tires.

I found that larger tires on the front wheels gave approximately forty-five per cent greater mileage than the standard 30 x 3 inch tires and that the cost of the larger tires was only thirty per cent greater.

About a year ago when the prices of tires began to advance, I resorted to the use of "double tread" tires. These tires are made of two used casings of the same size and have the same appearance and offer the same advantages as oversize tires. The bead is cut off of one casing which is then forced over the other casing and the two held together by two rows of stitching extending along each side wall. I have obtained good results by the use of these tires both from the standpoint of economy and freedom from punctures.

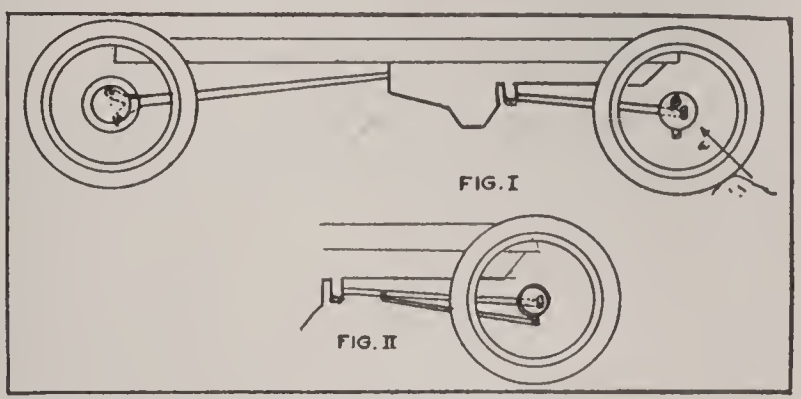
J. Adam Palm, Mt. Vernon, N. Y.

BRACING RADIUS RODS

MY Ford lying on her side in the ditch, friend wife badly shaken up and scared worse, myself somewhat scratched and baffled as to how to make a temporary repair that would

last twenty miles back home—all caused by a broken front radius rod—first made me give serious thought to that part of the car, which previously I had taken for granted the same as a door handle.

Radius rods are Ford essentials. Without them the front wheels could not be steered nor the rear wheels driven, and an accident to the radius rod usually means an accident to the car and passengers. The amount of strain on these radius rods is in direct proportion to the speed of the car, the weight of the loaded car, and the irregularities of the road, and,



J S.G. Radius Rod Brace

naturally, a well loaded car driven over rough roads has far more need for extra strong, or braced, radius rods than a runabout driven on paved streets.

Fig. 1 shows the effect of a road bump. The force is expended in two directions, up and back, which is equivalent to between the two right angle directions, about the direction of "A." If this force is greater than the strength of the radius rod one of two things must happen. Either it will be sheared off at point "B," or one or both sides of the rod will be bent to the shape of an inverted V, and both of these things have the same result, the steering gear becomes useless and a more or less serious accident is almost a certainty. Nearly every unavoidable accident to a Ford attributed to a deranged steering gear is caused by a broken or bent front radius rod.

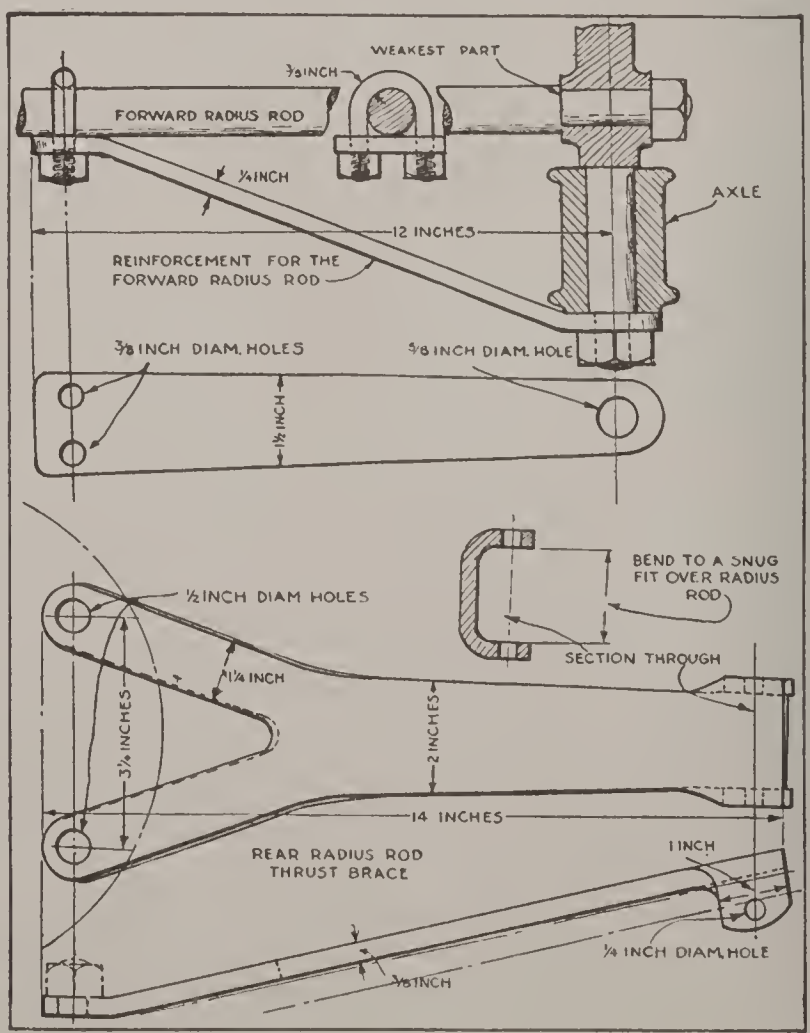
Bracing is the logical method of strengthening a front radius rod. A tubular L or I beam brace has much greater strength than a solid brace of the same weight. This brace should be placed as in Fig. 2, from below the front axle to near the rear end of the radius rod, in a way that no amount of rearward force can make the brace go further back than where originally fastened. Since there are a number of good braces on the market that can be bought for $2.50 or less,

there is practically no economy in a home-made brace. The front radius rod with the auxiliary brace gives a "three point" radius rod, which construction is mechanically right.

A glance at the sketch of the rear radius rod shows that this part is made in this desirable manner, and in an interview with a large jobber in this city who handles Ford parts. I was told that he had shipped to repair men in the "Rough Road" sections of Virginia and the Carolinas more than twelve hundred front radius rods during 1918, but never carried rear radius rods in stock because he never had a call for them. J. S. G., Richmond, Va.

Re-inforcement Essential

The slenderest parts of the forward radius rods on a Ford chassis are the machine turned connections which go through the spring perches. The front axle has a normal slant for-



ward of about five degrees, but with a Ford used for heavy work or trucking purposes this slant is increased by permenanent bending at this weakest spot, until rapid wear of the front tires gives a "costly" reminder that something is wrong.

A reinforcing bracket, which we have successfully applied to several converted Ford trucks, is as shown in the accompanying sketch and consists of a one and one-half inch wide by one-quarter inch thick flat steel plate, drilled at one end for a five-eighth inch bolt and at the opposite end is drilled for three-eighth inch bolts. It is held under the axle by the nut which fastens the spring perch down and at the radius rod, is held by a "U" shaped hanger and two nuts. The hanger is simply a piece of three-eighth inch steel rod, threaded at each end and bent to the required shape. This feature is inconspicuous and can be made from most any flat material, such as a broken spring leaf. While in service it safeguards the car against the danger of radius rod breaking or against abnormal tire wear.

Without a reinforcement of this kind, a Ford should never be towed by a line direct to the axle, for this will bend the radius rods immediately.

The rear radius rods are frequently bent, about eight inches forward of the "Y" shaped arms, connecting to the hubs of the rear axle. This is due not so much to overloading, but to heavy pulling through sand and hilly country when the car is driven vigorously in low gear. In two instances I have seen the radius rods not alone bent, but the attached ends of the rear springs also, with the rivets in the axle housings sheared and loosened.

A brace to strengthen this part by carrying the torque or thrust farther away from the axle is shown also in the sketch. The idea was borrowed from a Virginian who uses his car in the Blue Ridge Mountains and had an ingenious blacksmith undertake the job of strengthenenig the rods, which he did with similar braces.

The braces are of three-eighth inch flat plate steel, fourteen inches long. The shape of the fasteners and the widths are similar to the rear ends of the rods, now on the car. The "Y" ends are drilled one-half inch in diameter for the hub bolts and the forward ends have one-quarter inch holes for similar sized bolts.

The most important part of fitting a brace here is to have

the hub bolts snug fitting and the forward end, a push fit on the sides of the radius rod, a sort of three point bearing.

When the radius rod deflects as it does, though but slightly, the brace will be bearing against the hub bolts and radius rod and make it into one solid rigid support, and quick starts or stops with a loaded car on a grade can be made without danger of this weak spot in the rear radius rods giving way.

G. A. Luers, Washington, D. C.

CHAPTER XXVIII

GENERAL MAINTENANCE SUGGESTIONS

CUTTING DOWN OPERATING COST

IN operating my Ford car from January 1, 1916, to December 1, 1916, I find that the record kept of the operating costs reveals some interesting facts. In order that these facts may be intelligently discussed, the items of cost are shown in the following table:

Mileage for 11 months	5,367
Interest	$41.80
Miscellaneous	25.85
Repairs	45.45
Gasoline (287 gallons)	66.78
Oil (33 quarts)	7.35
Tires	90.05
Total	$277.28

Interest is figured at 6 per cent on $512.00, the cost of the car and extra equipment. Miscellaneous expense includes washing, storage when away from home, ferry, tolls, charges, etc. Repairs include such charges as are generally grouped under this head. Gasoline costs twenty-five cents per gallon as a rule, although a few mountain trips when it was necessary to pay eighty cents to a dollar a gallon ran the average up to twenty-six and a half cents per gallon. A high-grade of cylinder oil was used and one standard brand was adhered to costing eighty cents per gallon. Tire costs include casings, tubes and repairs to same.

The car has been operated over dirt, gravel and cement roads on the floor of the Sacramento Valley for about eighty-five per cent of its mileage and the Sierra Nevada and Coast Range mountains the balance of the time. The car had run 6,036 miles prior to this record.

From the table it will be seen that the item of tires is the

largest single expense in operating the car, as it amounts to .0167 cents per mile. Non-skid tires of a well-known make, ranking second in point of cost to any fabric tires made, were used on the rear wheels during the eleven months under consideration. Three-inch tires of a cheaper grade were used on the front wheels for a time, but as they bruised and cut much more readily than those on the rear they were replaced with three and one-half inch tires of the same make as the rear tires, resulting in a reduced number of punctures and a less cost per mile. This change in connection with buying the best tires to be had on the market is offered as an important suggestion in reducing tire cost.

The average cost per mile for gasoline was .0124 cents, making it next to tires in point of expense. As the car averaged 18.7 miles per gallon of gasoline over a long period with varying road and weather conditions, the only suggestion for increased mileage would be to use a little more care in adjusting the carburetor from the seat after the car was on the road.

Oil shows a very satisfactory mileage, the car having made 162.9 miles per quart. This was obtained by using a high-grade of oil, keeping the oil-level always between the pet cocks on the crank case, and keeping the gaskets on the engine in good condition. The cost per mile of but .000136 cents for oil is so low that no can afford to use anything but the best grade of lubricant.

The above figures show a total cost per mile for tires, gasoline and oil of .02936, or almost three cents at the California prices for gasoline and oil.

Repair expense may seem to be large, but as the car had already traveled 6,036 miles and all repair work was done immediately and thoroughly by high-priced mechanics, the figure is in reason.

From the foregoing it is shown that the total cost per mile, including every charge that should properly be made by the man who drives his own car and keeps it at home, is .0516 cents per mile.

CHARLES B. WEEKS, Red Bluff, Cal.

Systematic Care the Best Economizer

On June 1st last I purchased a 1914 Ford that had been run 10,000 miles. It appeared on the surface to be in good condition, and like a chump I took the salesman's assurance of recent thorough overhauling as the truth.

When I later got through overhauling, which included a complete overhauling of engine transmission and rear axle, I had spent just $60 more on the car. Having overhauled everything but the muffler, I know it is in good condition now.

During this five and one-half months we have driven 3,905 miles over roads ranging from asphalt streets to mountain corduroy and crushed rock spread loose. Our average speed has been from 15 to 22 miles, usually 18 or 19. In my opinion, on average roads, one has no business going over 20 miles with a Ford unless he is in a hurry to wear it out and get a new one. The tires on my car—Goodrich in front and Nobby Tread in rear—had gone about 2,000 miles when we got the car. They now stand about 6,000 miles. I expect 1,500 more from the front tires and 2,000 more from the rear.

After I reached 4,000 miles' wear I put full innerliners in all tires. We have had four punctures, no blowouts or other tire troubles. We have a good pump and pressure gauge and use them both. My son and myself take all care of the machine. We keep it clean, tight, full of oil and gas, and treat it right. I shall repaint the car this winter. The only prospective expense for next season will be new tires all round, when we will be ready for five or six thousand miles in the open air.

Costs:	
Complete overhauling	$60.00
Extras—accelerator, pump, wrenches, etc.	10.00
	$70.00
Operating cost:	
Gas, 177 gals. at 20 cents	25.40
Oil, 6 gals. at 80 cents	4.80
Innerliners	10.00
Inner tubes, two	7.00
Tube repair material	3.00
Gas saver	1.00
	$61.20

Thirty-nine hundred and five miles at a cost of $61.20 is 1.58 cents per mile. This average cost will decrease per mile until new tires are necessary, but will never exceed

two cents per mile. Even if I add overhauling costs to operating cost it then only reaches 3.35 cents per mile.

Against total expense of $131.20 is $17 street carfare saved, the smallest doctor-bill in years, improved health of family, and a love for the open we never had before.

Of the legion of accessories, we have only tried three—a foot throttle, which I would not do without; an oil gauge and a gas saver, which helped about two miles per gallon. We are waiting for more proof as to some loudly advertised articles.

My best advice about cutting down expense is not to make the expense in the first place. Fast driving is the most expensive thing of all, unintelligent use of carburetor next so. Go out for the pure pleasure of the drive, not to see how fast you can go. Never mind what the other fellow does—attend to your own business, obey all traffic rules, read a good trade paper and keep a scrap book of sensible hints, and you will have many thousand miles of pleasure at a most reasonable cost.

In short—moderate speed, careful usage, intelligent cleaning and care, repairs at the instant needed, and treatment as a piece of fine machinery and not a lumber wagon, will answer the question of economy.

J. H. Zehrung, Portland, Ore.

CHAPTER XXIX

COLD WEATHER DIFFICULTIES

PRACTICALLY all of the troubles found in operating the Ford car during the winter months are directly due to poor vaporization of the fuel. The answer to all of the problems presented is the proper application of heat, both for easy starting and for efficient running.

The worst trouble is encountered in starting the engine. One may crank sometimes for half an hour without getting a single explosion, except an explosion of temper. One may prime an engine until gasoline leaks from every pore (figuratively speaking) with no better results. Possibly after a time, with a splutter and a skip, the engine starts. It may be that after ten minutes of running the engine will begin to function normally, but the mileage per gallon of gasoline is low.

The writer has had all of the trouble of trying to persuade a balky Ford engine to operate that the average motorist encounters. He has come to the conclusion that reasoning with the machine does no good; cussing less; and hot water poured over the carburetor is both unhandy and messy. Fortunately his garage is wired for electric lights, a fact that enables him to solve the whole problem of starting.

About fifteen minutes before the car is to be started, an old electric flat iron heating unit is connected with the lighting circuit and slipped in back of the carburetor. By the time the car is to be started, the carburetor, manifold and side of the engine is heated to such an extent that the gasoline vaporizes even better than in summer. The engine will start on the first turn. The device is rather crude but strikingly effective, for it sure does prod the old engine into action on a cold morning.

So much for starting the engine. While on the road, the lighting circuit is hardly practical as a source of heat supply, so other means must be resorted to in order to keep the fuel warm. The ordinary Ford stove on the manifold is rather small for extremely cold weather, so to get the degree of heat necessary for good vaporization a hot air stove. made from a length of tin extending the whole length of the ex-

haust manifold, is attached. The connection is made with the regular carburetor pipe in the usual way, the results being extremely gratifying.

If the Ford owner does not have light connections in the garage he may adopt either of the following means for starting the refactory engine. Soak a sponge with ether and hold it against the carburetor intake; this usually brings prompt results when the car is cranked. He may put a coil of German silver wire around the carburetor bowl and connect either with the storage battery or four dry cells. The coil must, of course, be insulated from the bowl.

Ford cars are not fitted with priming cocks, but the owner may install one priming cock in the manifold at the V, through which a drop or so of ether may be poured. This liquid is very volatile and furnishes enough gas for the first two or three explosions; after this the engine will usually run on the gasoline in the carburetor.

F. L. A., Providence, R. I.

Many Helpful Sugestions

The first cold weather trouble with the Ford came after having it drained of course, in the yard all night, with the temperature below freezing. In the steam-heated garage the motor turned easily on cold mornings, but this morning it was impossible to spin it even when filled with hot water. The congealed oil needed the heat of an internal explosion to loosen it. Six dry cells were hooked to the vacant post on the coil and the stiff motor trouble was overcome. Four turns with the air shut off and two with the valve open, and the engine goes. Just a bit more gas at first, but that can be cut down in a minute or two.

The stock hot air pipe is very susceptible to cold, and a puff of cold air will slow the engine up at once. After having this happen a few times, also having the engine stall from a too sudden opening of the throttle, an automatic air valve and hot air pipe combined was put on. That two-minute job stopped the air trouble. The first result of the new air tube was one-half turn less on the needle valve; also the sudden and sometimes unavoidable yanking open of the throttle does not stall the engine. The automatic air valve can be heard picking up just the right amount of air for the situation and the engine goes right along without a kick, and picks up without choking to death. Also the

car throttles down much better and the engine pulls at low speeds, both of which help in traffic.

Then came a patent manifold with exhaust and inlet in one casting. This is a great help on the getaway. Crank her up and by the time the driver is ready everything is running as smoothly as in summer and there is plenty of power. This does not mean that one should at once go out and race or climb a heavy hill, as the oil has not had a chance to warm up and to flow properly. But the engine is there with its smooth running and power and one can go down the street on high and not popping and banking on low, trying to "warm her up."

Following the suggestion of G. A. Luers in the December MoToR, the needle valve adjustment was carried to the steering column and that has turned out "some improvement." No trouble to adjust for the varying road conditions as they come.

The commutator was carefully cleaned and is now oiled with light oil. The Ford company recommends one-quarter kerosene, but kerosene is not much of a lubricant and a good light oil is better, in my judgment, backed by experience.

The radiator was filled with a good non-freezing compound, a radiator cover fitted and a thermometer put on the radiator cap. If the meter is watched and the cover adjusted to help keep the red liquid at "hot motor," the power and economy are greatly improved. Most Fords run too cold in winter.

Care must be taken to see that the proper oil and grease are used. A lighter oil than in summer, as many oils will not run at low temperatures and something may burn out before the oil can get warm and flow properly. A lighter grease should be used in the cups—vaseline is good—and some heavy oil, such as black steam engine oil, should go in the differential. Or else a small amount of engine oil should be mixed in with the grease to prevent the gears from merely cutting a channel. Oil all cups carefully and see that the oil goes where it is intended and is not blocked by water and snow freezing in the oil channels. Put chains on all four wheels and the Ford will run in any winter weather with the best of them.

J. C. C., Yonkers, N. Y.

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